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Pattern and Responsiveness to Ocular Complaint among Secondary School Students Learning Remotely During COVID 19 in Trinidad

A Quantitative Study

OPTM 3082 RESEARCH PROJECT

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ABSTRACT

Background: The Covid-19 pandemic introduced new laws and regulations worldwide to lower the risk of more people contracting the virus; one of them being that schooling would be done from home via online learning. Online learning required the use of digital devices and lengthened exposure to these devices can cause Digital Eye Strain which is also knows as Computer Vision Syndrome).

Aim: To assess the pattern and response of ocular complaints among secondary school students studying remotely during the Covid-19 pandemic.

Method: A quantitative observational cross-sectional approach was conducted among 435 secondary school students with the use of a structured questionnaire which assessed factors such as demographics, digital device usage, pattern of ocular complaints, responsiveness to ocular complaints, nature of management of ocular complaints and the effect on the student's health and how it affected their life.

Results: The most common ocular complaint experienced was found to be headaches (281 students). Although the remaining four ocular complaints were not as prevalent, there was an increase in each of these complaints during online learning due to Covid-19 as opposed to before Covid-19 which can be due to the increased time spent on digital devices. A large majority of students (304 students) did nothing to resolve their ocular complaints.

Conclusion: The second highest majority of students (142 students) said that their quality of life was severely affected and the majority of students (304 students) did nothing to resolve their discomforts which can have serious implications later on in life.

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LIST OF ABBREVIATIONS AND ACRONYMS

AOA- American Optometric Association

CVS- Computer Vision Syndrome

CVI- Content Valid Index

COVID-19 – Coronavirus Disease 2019

CRT- Cathode Ray Tube

DES- Digital Eye Strain

LCD- Liquid Crystal Display

MSD- Musculoskeletal Disorder

RNA- Ribonucleic acid

SARS-CoV-2 – Severe acute respiratory syndrome coronavirus 2

SPSS- Statistical Package for the Social Sciences

UWI- University of the West Indies

UAE- Unites Arab Emirates

UNSW- The University of New South Wales

VDT- Visual Display Terminal

DEFINTION OF TERMS

CVS- [1]Computer Vision Syndrome also sometimes called digital eye strain is a group or set of eye or vision related problems caused by excessive computer or digital device use.

MSD- [2]Injuries and conditions that affect the movement of the human body or the musculoskeletal system comprising of tendons, ligaments, muscles, discs, blood vessels, nerve, etc.

Optometrist- [3]An independent primary health care provider who examines the eyes to evaluate health and visual abilities, diagnosis eye diseases and conditions of the eye and visual system, and provides necessary treatment such as eyeglasses, contact lenses, vision therapy and low vision aids.

Ophthalmologist- [4]A physician who specializes in diagnosing and prescribing treatment defect, injuries and diseases of the eye and is skilled at delicate eye surgery.

[1] Computer vision syndrome (Digital eye strain) [Internet]. Aoa.org. 2021 [cited 21 May 2021]. Available from: https://www.aoa.org/healthy-eyes/eye-and-vision-conditions/computer-vision-syndrome?sso=y

[2] Musculoskeletal Disorders - Causes, Symptoms, Diagnosis [Internet]. SIMS. 2021 [cited 21 May 2021]. Available from: https://simshospitals.com/musculoskeletal-disorders/

[3] optometrist [Internet]. TheFreeDictionary.com. 2021 [cited 21 May 2021]. Available from: https://medical-dictionary.thefreedictionary.com/optometrist

[4]ophthalmologist [Internet]. TheFreeDictionary.com. 2021 [cited 21 May 2021]. Available from: https://medical-dictionary.thefreedictionary.com/ophthalmologist

Chapter One

1.0 INTRODUCTION

2.0

The transition to remote learning in Trinidad occurred in March 2020 because of the changes implemented to combat the COVID-19 pandemic. The pandemic was declared in the mentioned month by the World Health Organization (WHO), due to the rapid spread globally of the novel coronavirus which was later called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), widely known as COVID-19.[1] Despite the large attempts made to confine the disease in Wuhan China, where it originated, it was still able to spread to approximately 221 countries, infecting around 121 million persons globally. [2],[3]. This virus was not only infectious, but also caused roughly 2.6 million deaths worldwide, which lead to many changes in daily life, where most of life's interactions now relied heavily on technology. [4]

As mentioned previously, countries were placed on lockdowns which lead to schools and universities closing to follow the rules of physical distancing and limit the possibility of transmission of the disease.[4] Globally at least 80% of students from over 130 countries were affected by the lockdown, where some countries swapped face to face teaching with the use of technological devices. [5]

In Trinidad and Tobago, similar to many other countries, remote learning became an immediate response to deliver education, where students now used multiple means such as phones, laptops. tablets, television and other devices, to access their curriculum. Prior to COVID-19 there was no emphasis on the use of online teaching. [6] As education is being shared to the students via online platforms which require devices, there is now the risk on the eyes of students to consider, as it is necessary for them to be positioned in front of this device for several hours a day.

This topic was chosen as it was evident that this digital way of educating students would now be the new widely accepted way of schooling, especially as the duration of the pandemic and the length of time its effects would

remain, is unforeseen. Lengthened exposure to these devices, pose a threat to student's eyes as it can cause digital eye strain also known as Computer Vision Syndrome (CVS). [7] This can be brought on by the increased workload on the eye that exceeds the visual capabilities of the individuals leading to symptoms such as eyestrain, headaches, blurred vision dry eyes and neck pains. The extent of the ocular symptoms experienced does not only depend on their visual capabilities but also the amount of time spent looking at the screen. [7] In addition, this research was chosen to be conducted as there were no studies done on the correlation of online learning and its effects on the ocular health of students in Trinidad. This research study is also geared towards raising awareness of ocular health and associated symptoms amongst the general population, consisting of students, teachers, parents, and optometrists.

1.1 BACKGROUND

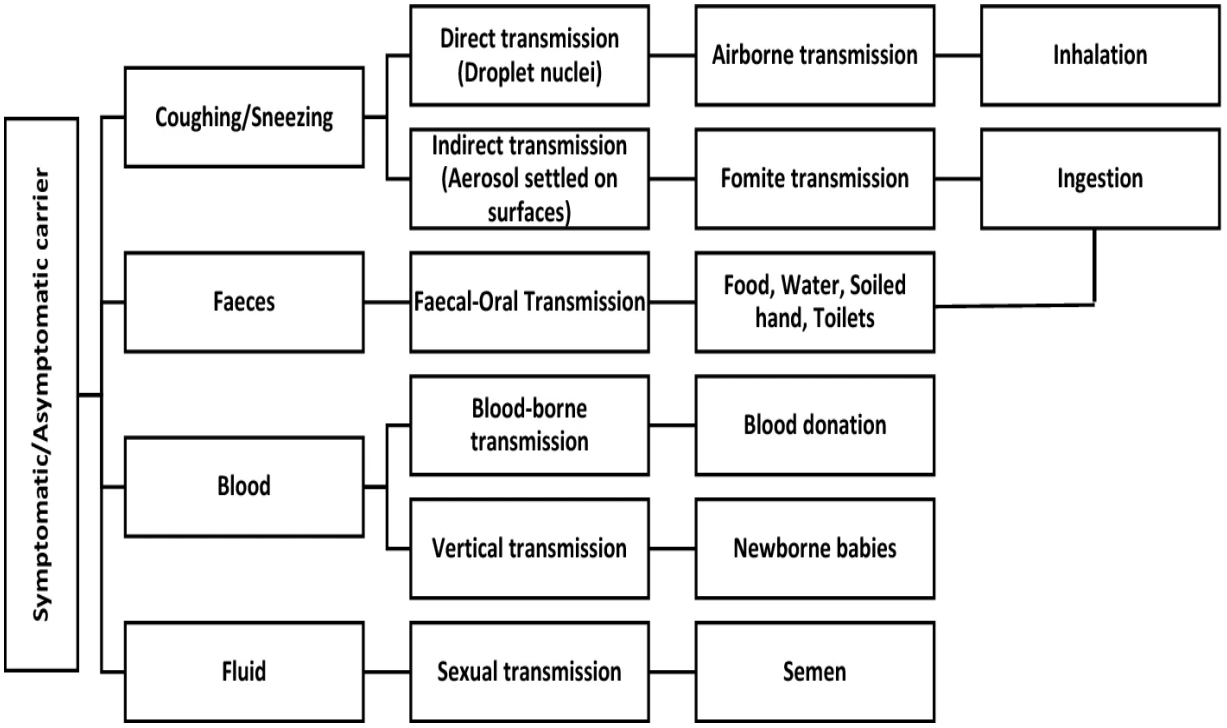
1.1.1 Mode of transmission of COVID 19

The Novel Coronavirus, now widely known as COVID-19 is a disease caused by the newly discovered strain of coronavirus.[8] The virus which causes COVID-19 is part of the family of viruses which include: Severe Acute Respiratory Syndrome (SARS), the common cold and Middle East Respiratory Syndrome (MERS).[9]. The mode of transmission of COVID-19 was understood through the emergence of scientific evidence of the SARS-CoV-2 virus. This virus can be transmitted through many ways such as through contact, droplet, airborne, fomite, mother-child, fecal, oral, blood-borne and human to animal interaction.

Contact transmission can be either from indirect or direct contact with persons who are infected with the virus. This contact can be with bodily secretions of the infected, such as saliva or respiratory droplets when coughing or sneezing, which however is also referred to as droplet transmission. Transmission through respiratory droplets occur when someone is within 1 one meter contact of the infected person. Similarly, transmission can be through airborne, where this is the spread of the virus through spread of the droplet nuclei. This is different from contact transmission as respiratory droplets are 5-10micrometers while droplet nuclei are less than 5 micrometer[10]. When infected respiratory droplets land on surfaces, they now contaminate these surfaces with the virus, which allows for formite transmission, as the Ribonucleic acid (RNA) of these viruses can remain on the surface, however this has not been studied directly[10]. It has been noted from various studies that persons with severe COVID-19 tend to have a higher concentration of viral particles of SARS-CoV-2 in their faeces, such as the RNA, which leads to the belief that the virus can be spread through this bodily secretion. However, there has only been a view that have identified a viable virus, therefore not giving enough evidence to prove that it is spread through fecal pathways. In terms of zoonotic transmission, there is little evidence that has been able to associate the transmission of SARS-CoV-2 virus between animals and humans. However, experimental

studies have shown that several mammalian species such as cats, dogs, bats and ferrets can become infected with the virus[11].

Figure 1 Showing Flow Chart of Different Modes of Transmission of COVID-19 Virus



The risk of transmission of the disease at a particular period of infectiousness due to the onset of viral shedding is not yet known. However, it is believed that mildly to moderately infected persons go through viral shedding for up to 10 days after onset, whilst those severely affected may go through shedding for up to 20 days.[12]

Due to the many modes of transmission of the SARS-CoV-2 virus, various countries implemented Public Health policy changes to combat the spread of the virus. Governments' introduced policies such as mandatory face coverings, restrictions on travel, gatherings, school and office closures and cancellation of public events. The table below is current data as recent as March 28th, 2021, as part of ongoing research by an Oxford university team, that compares countries and the severity of policies implemented. [13][14][15].

Table 1 Showing The Various Changes made by Governments of The US, UK, China, Nigeria and Trinidad to Combat the Spread of COVID-19

	Government stringency index	Face covering	school and workplace closures	stay at home restrictions	international travel controls	cancellation of public events	restrictions on public gathering
US	58.8%	required outside the home at all times	required at some levels	Recommended	Ban on high risk regions	Recommended Cancellations	<10 people
UK	78.7%	required in all public spaces	required at some levels	required except essentials	Ban on high risk regions	Required Cancellations	<10 people
China	50.0%	required in SOME public spaces	Recommended	Recommended	Ban on high risk regions	Recommended Cancellations	>1000 people
Nigeria	45.37%	required in all public spaces	Recommended	required except essentials	Quarantine from high risk regions	Recommended Cancellations	10-100 people
Trinidad	64.81	required outside the home at all times	required at some levels	No measures	Total Border Closure	Required Cancellations	<10 people

All countries chosen in this sample set have introduced stringent measures to limit transmission through contact and droplets. Schools in most countries through-out the pandemic have been recommended to close or to limit the number of persons entering the compounds. One example of this is such that many areas of the United Kingdom allow schools to be opened only to children of those classed as “essential workers”.[16] Trinidad has been extremely cautious in this regard and are only allowing schools to be opened solely for the purpose of carrying out physical exercises such as laboratory experiments. [17][18]. As a result of this, most countries in the world have largely moved schools to online - based methods of learning.[19][20][21]

1.2 STATEMENT OF PROBLEM

The transition to online learning posed many challenges globally for students, educators and parents. The lack of infrastructure, limited exposure of educators to online deliverance of education, the information gap and a non-conducive environment for learning at home, are some of the dearth of this transition[22]. Due to the inability of some developing countries to have access to reliable internet connection or access to a device due to affordability, this leads to a disadvantage faced by students of these backgrounds, leading to the decrease in academic performance of students 22]. A study done on the impact of COVID-19 on the academic performance of veterinary medical students showed that some of the disadvantages faced were: loss of interest, loss of motivation to participate along with sleeping issues, lack of effective communication, a sense of loneliness, difficulty learning practical skills with online lectures, lack of availability of internet for those in rural areas and the lack of availability of devices for learning such as laptops, tablets and smartphones.[23] Another study conducted to determine the impact of the COVID-19 lockdown on the digital device related ocular health, showed that the relationship between the number of ocular symptoms experienced and the increase in screen time was directly related. This is so, as it was determined that an increase in screen time, lead to an increase in the amount of symptoms experienced, as well as the intensity and frequency of which they occurred.[24] In addition to the effect on the ocular health, it has been noted that respondents of this study have stated that the use of these digital devices have led to sleep pattern disturbances due to the inability to fall asleep on time. [24]

Users of digital devices can experience some level of ocular discomfort. Some common ocular complaints amongst users of these devices are: Dry eyes, eye strain, blurry vision, double vision, headache, eye pain, redness, watery eyes and difficulty focusing as well as itching and burning.[25][26] These range of complaints can be associated with Digital Eye Strain (DES) also known as CVS and can be grouped into two categories of symptoms such as: external symptoms which are usually linked to dry eyes and internal symptoms, usually linked to accommodation or binocular vision implications.[27]

From previous studies conducted it can be seen that the factors which can lead to ocular complaints amongst users are: duration of device use, viewing distance to the device, use of spectacles, use of antiglare screens, height level of screen to eye and the amount of visual breaks taken by the user. [25][28][29].

As the use of digital devices become more relied upon due to the pandemic, this therefore means that any strain encountered can affect the quality of life of the individual. There are still not many studies that investigates how this may affect the quality of life. However, it is understood that the presence of vision impairment can result in discomfort from the symptoms which has the potential to be disruptive to everyday life by reducing the productivity at work as well as the ability to enjoy leisurely activities.[30][31]. In terms of the artificial blue light emitted from these devices, it has been noted that use in the evening or night can cause disruption to the natural sleep-wake cycle of the body, known as the circadian rhythm. This occurs at it can trick the brain to not produce melatonin before bed, leading to persons feeling less sleepy at time of bed.[32][33]

Understanding the pattern of ocular complaints faced by persons who use digital devices can assist not only to educate these persons on how to reduce the effects, but also to learn what can be done to improve devices to minimize the negative effects on the eyes.

The transition can be a problem as it can now interferes with the ocular health of persons, especially students who may be in front of devices for hours for their schooling. The introduction of such ocular strain at a younger age, can lead to the formation of more troublesome ocular difficulties or reduced efficiency throughout daily life.

This research, as previously stated aim to analyze the pattern and responsiveness of ocular complaint of students who have been learning remotely from home due to the pandemic. As there is little research currently on the effects of the online learning to the ocular system, we hope to gather evidence and data which will lead to the further understanding of the issue at hand, and thereby lead to treatment or prevention for future students. This will assist teachers, students, families and the respective educational and health organizations to understand all

that is needed to prevention further ocular damage and the various ways in which can preserve the ocular health even amidst the switch to technological dependence.

1.3 AIM

To investigate the pattern and responses of ocular complaints among secondary school students studying remotely in Trinidad due to the COVID-19 pandemic.

1.31 GENERAL OBJECTIVES

To assess the pattern and response of ocular complaints among students studying remotely in Trinidad.

1.32 SPECIFIC OBJECTIVES

- To explore the pattern of ocular complaints among students
- To assess the factors that contribute to ocular complaints among students learning remotely in Trinidad
- To evaluate the response of ocular complaints among students
- To assess the impact of learning remotely on students' quality of life.

1.4 RESEARCH QUESTIONS

We aim at obtaining the necessary information required to fill the objectives stated, by asking the questions of:

- What are the patterns of ocular complaints among students learning remotely?
- What factors contribute to the complaints?
- How did the students respond in resolving these ocular complaints?
- What are the impacts of these complaints to their quality of life?

Any findings obtained during this study would and can be used to further bring awareness to ocular health, the effects of devices on the eye and what can be done to eliminate or reduce the strain experienced by the eye. This study focuses only on secondary school students in Trinidad that are within age range of 12-19 years old.

1.5 SIGNIFICANCE OF THE STUDY

This study done on the secondary school students of Trinidad will help to determine the impact of remote learning since the emergence of the COVID-19 pandemic. Understanding the patterns of ocular complaint amongst the students, the factors that can contribute to these complaints, the ways in which the students has responded to them as well as the impacts these complaints has on the lives of the students, will give insight on the ways in which they can be combatted. This study also can bring awareness and help to educate the students and the public on how to eliminate complaints caused by prolonged use of their digital device,

1.6 DELIMITATION

This study concentrated on Secondary school students in Trinidad, aged between 12-19 years of age, who are citizens of Trinidad and Tobago and have been living in Trinidad for the past year. This study first targeted one school each from the 7 districts of Trinidad, being Caroni, North Eastern, Port of Spain and environs, South Eastern, St. George East, St.Patrick and Victoria. However, we then opened the study to students from any school to reach a larger audience.

1.7 LIMITATIONS

There were various limitations encountered during this study. The delayed responses from schools was one major limitation as it lead to the delay in commencement of the study as we required their permission in order to distribute the questionnaires. Likewise, when questionnaires were distributed, many schools also delayed in answering the questionnaire which lead to a further stall in the progression of the study as analysis was not able to be completed until our target number was met. Additionally, From the number of schools contacted, only a small fraction responded, which left the study with inadequate amount of data from the respective districts, which lead to us changing the sampling method from purposive to random in order to reach various students nationally.

Another limitation found, was through the data collection method. Due to the survey being conducted online, it was unknown which students have truly been granted permission by their respective guardians to participate in this study as the consent forms would be filled and sent electronically. In addition to this, the use of an online survey can lead to miscommunication as students may miscomprehend the question being asked. Online surveys can also cause answers to not be extensive as compared to information gathered collected through interviews or focus groups. Also, there was unequal number of students per class grade that participated in this survey, therefore making the results skewed and dominated by one class group.

Additionally, there was limited literature available on this topic that was suitable for use, giving rise to some difficulty in comparisons of our results.

Chapter 2

Literature review

This chapter presents the review of previous studies related to the topic. The researcher reviewed literature related to the pattern of ocular complaint among digital users, responsiveness to ocular complaint, evaluation of the factors which contribute to ocular complaint in computer users and quality of life among digital users and summary of the research gap.

2.1 Introduction

Due to the use of technology which has become extensive in order to keep track with normal day to day activities such as; socialising, working and obtaining an education. The increased time spent in front of these devices which are regarded as helpful tools, can simultaneously harness ocular complaints amongst its users, which can affect their daily lives.

2.2 Pattern of ocular complaint among digital users

In a study conducted to assess the pattern of computer use and related vision problems among University Students in Ajman, United Arab Emirates(UAE), it was concluded that almost half of the surveyed students stated that they had computer-related visual problems. Common visual problems were noted amongst the 471 responders, where reports stated that 53.3% (251 students) had experienced headaches, 54.8% (258 students) had burning sensation in their eyes and 48% (226 students) had dry/tired/sore eyes. In addition to this, almost 72% of students reported frequent interruption of computer work, where 43.85% of those stated it was due to headaches and 43.5% stated the interruption was due to tired eyes[34]. It was also seen as a pattern that dry/tired/sore eyes were more prevalent amongst those students who viewed their screens for longer durations. As the viewing distance increased for these students, their complaints inversely, decreased by 38%. Also, the prevalence of tired eyes was increased by 89% when screen filters were not used while on their computers[34]. Therefore, sustained periods of near screen work without filters were found to be associated with increased interruptions of the work of the students as well as an increase in the occurrence of these ocular symptoms experienced. These visual problems have led to 4-8% slower performance on occupational tasks and could prove to decrease student's productivity[34]. Visual complaints were also seen more amongst students who did not take frequent breaks from their computer. This is because the eye muscles can become tired in a stationary

position leading to fatigue of accommodation. Also, it was seen that during use of the computer, the blink rate of students reduced from a normal 12-16 blinks per minute, to now 6-8 blinks per minute, resulting in dry eyes[34]. However, with the use of screen filters there was no longer a reduction in the blink rate as the reduction of glare and reflection prevented such.[34]

In a study done to assess computer vision syndrome among undergraduate medical students in King Abdulaziz University, Jeddah, Saudi Arabia, there were a total of 651 participants of which 90.2% (587) used computers for studying. 54.3% (319) were females and 45.7% (268) were males. The participants' ages ranged from 19 to 27 years old with a mean age of 2.65 years. With regards to refractive errors, 22.6% (147) had myopia, 14.7% (96) had hyperopia and 11.7% (76) had astigmatism. 40.9% (266) of the participants wore glasses and 10.4% (68) wore contact lenses for vision correction during studying. Also, 15.3% (90) were known to have dry eyes.[35] However, the presence of myopia and hyperopia was not associated with CVS but astigmatism showed significant association with CVS specifically headaches and increased sensitivity to light. It should also be noted that females were observed to have higher risk of CVS. The results of the study are as follows: the most commonly reported ocular symptoms were excessive tearing (20.6%) (121), dry eyes (20.3%) (119), itchy eyes (18.9%) (111), increased sensitivity to light (16.2%) (95), eye redness (15.1%) (89), burning sensation (15%) (88).The most common extraocular complaints were neck, shoulder or back pain (39.7%) (233), headache (30.1%) (177) and numbness of the hands or fingers. The researchers came to the conclusion that development of CVS was greatly associated with: female gender, astigmatism, pre-existing dry eye disease, longer duration of computer use and higher screen brightness. The researchers go on to state that the most significant preventative measure taken by students was application of the 20-20-20 rule[35].

The School of Optometry and Vision Science, The University of New South Wales (UNSW), conducted a study aimed at investigating the viewing distances and eyestrain symptoms experienced in young adults after reading an extract from a smartphone for sixty (60) minutes [36]. This was done by giving subjects a survey related to common eye strain symptoms, before and after use of the device, whilst the viewing distance was measured by photographs taken each minute. The subjects were noted to have normal visual acuities and no binocular vision or accommodative disorders. The results of this study showed that the viewing distance was greater in the first ten (10) minute interval with 30.6cm which decreased in the final ten (10) minute interval to 27.8cm. It was also seen that the symptoms of blur, tired eyes and uncomfortable eyes increased after use of the smartphone. This therefore allowed the investigators to conclude that there was a significant correlation between the viewing distance and eyestrain symptom as closer distances cause greater effect of symptoms. This conclusion confirmed one of the findings in the first study, [34], that the viewing distance is directly related to ocular complaints, as the increased distance caused the complaints to decrease.

In another study, the above information from both studies were confirmed as the findings were similar. This study was done by the Department of Nursing, Abadan University of Medical Sciences in Iran, where it's aim was to investigate ocular symptoms of computer users in an administrative workplace [37]. This study was carried out on 199 computer users where 78 were females and 121 were males, all aged between 30-40 years old with computer use time ranging from 21 to 40 hours a week. From the results it shows that of all the subjects, 38.2% complained of burning eyes as well as eye dryness, 41.2% complained of dizziness whilst looking at the computer monitor, 38.7% complained of teary eyes whilst use of the computer and 44.2% stated the display became dim. It was also seen that there was a significant relationship between the ocular complaints stated , the number of hours spent on the device, the position of the monitor and chair as well as the conditions in which the subject performed under.[37]

Based on these studies reviewed, it can be seen that the pattern of ocular complaints were similar throughout each of the studies, although there were different factors to be considered. These were burning and teary eyes, dry eyes and tired eyes. In addition to these symptoms it can be assumed that the viewing distance, filters used as well as work conditions can affect the symptoms experienced. However one way to help in the reduction of these symptoms is to apply the 20-20-20 rule as stated by one of the above articles[35]. Also while there are ocular symptoms associated with CVS it is important to remember that there are also extraocular symptoms such as neck, shoulder and back pain. While some articles may say the most common symptoms are headaches and a burning sensation and another article may say the most common symptoms are excessive tearing and dry eyes, a possible reason for the myriad of different symptoms experienced by the participants in these studies can be attributed to duration of computer use, gender, age, and if the participants take frequent breaks.

2.3 Responsiveness to ocular complaint

A report done by the American Optometric Association indicated that approximately 14% of patients get their eyes tested because they suffer from CVS and they are unaware of it[38]. According to a study done among medical students in a university in Karachi, Pakistan, the symptoms of CVS improved after taking more breaks but there was no significant association between the number of breaks and relief of symptoms. The study added that there is also research which suggests that taking breaks does not help with the symptoms of CVS while there are contrasting research which suggest the opposite; taking breaks lessens the symptoms of CVS. In a study done evaluating the prevalence and risk factors of CVS among computer office workers in Sri Lanka the researchers stated that taking breaks was not significantly associated with the prevalence of CVS. [38][39]

Another article by Dr.Tenen, a refractive surgeon from Melbourne, Australia indicates that the amount of patients that she sees complaining of symptoms related to Digital Eye Strain has tripled or even quadrupled due

to the increase in the use of digital devices due to lockdown restrictions because of Covid-19. The author also gave an example of a student who at the beginning of the year did not need glasses and now has a prescription of -5.00 D which is a significant myopic shift. [40].

It can be inferred that people who suffer with severe symptoms of CVS or DES may be unaware of it but visit an optometrist or ophthalmologist to get their eyes tested to relieve some of the symptoms. However, unfortunately, there is very little literature on the way patients respond to ocular complaints and what they do to help themselves before visiting an eye care professional.

2.4 Evaluation of the factors which contribute to ocular complaint in computer users

According to a study done among computer users in Uttar Pradesh, India, the factors that were focused upon consisted of the duration of use, distance from the computer, spectacle wearers, the height and inclination of the screen, use of anti-glare screens, brightness adjustments, the type of monitor used and breaks taken during computer usage. This study found that the longer the duration of computer work, the longer the symptoms were sustained even after working on the computer was finished. The closer the computer was to the eyes also contributed to the presence of eye strain and headaches. A distance of 50 cm - 70 cm should be maintained from the eyes to the digital device. Among the participants who did not wear glasses (65.4%), redness was the most common symptom. There were less complaints about eyestrain among participants who kept the top of the screen level below the eyes. Having screens higher than eye level resulted in greater eye strain. It was found that high illumination and sensitivity to glare caused a decrease in the attention of the user which caused an increase in the amount of time the person took to complete the task. Ideally, the brightness should be adjusted to be the same as the surroundings while the contrast needs to be set at the highest setting to remove discomfort. Persons who used antiglare screens had less eyestrain as opposed to the subjects without antiglare screens. Eyestrain and burning of the eyes were found to be associated with participants who took less frequent breaks. Frequent breaks allow the muscles of the eyes to relax, thus reducing the eye strain and headaches. The last factor in this study, the type of monitor, showed that the flat-panel LCD screens were easier on the eyes as they usually have an anti-reflective surface as compared to the CRT monitors which flickers, thus, causing eye strain. [41]

In another study conducted in Urban India among adolescents who used digital devices for various reasons which included: school projects, gaming, social networking, reading eBooks and looking at movies and videos also focused on factors which resulted due to ocular complaints. The factors of this study focused on: the type

of digital device used, the distance away from the digital device, the position preferred while using the digital device, a comparison between the time spent reading using paper versus the time spent reading using a digital device, frequency of use of the digital device, and digital device use at night. In terms of the digital device used 58.3% (336 students) used a smartphone, 37.3% (215 students) used a tablet, 35.8% (206 students) used a laptop, 23.8% (137 students) used a desktop computer and 9% (52) used an eBook reader [42]. In regards to the purpose of the using the digital device 66.7% (384) used it for school projects, 43.6% (251) used it for gaming purposes, 35.6% (205) used it for social networking, 30.4% (175) used it for reading eBooks and 29.5% (170) used it for watching movies/videos [42]. This study reiterated the importance of the ideal distance for computer usage, which is between 50cm – 70cm away from a person's eyes, however, the smaller devices such as smartphones are held at a shorter distance of 20cm to 30cm away from the eyes, thus leading to eye strain. More than half of the participants (56%) in this study maintained an ideal reading distance. In other studies, improper posture was also found to contribute to eye strain when the back was hunched which led to pain in the muscles of the back and neck, however, according to this study, most of the participants preferred sitting on a chair as opposed to laying down. As the age of the adolescents increased, so did the time spent on digital devices due to an increase of digital devices in the department of education; both at school as a teaching aid as well as at home to complete homework which requires computer usage, and in recreational time which includes social media networking, video games and surfing the internet. In this study, the most used digital device was a smartphone. The screens of digital devices emit blue light or high-energy visible light wavelengths and after constant usage over a period of time and as a result, eye disorders such as age-related macular degeneration or cataracts may develop. Blue light also has an effect on sleep due to the decrease in the secretion of melatonin which can reduce the quality of sleep a person gets, causing the person to be more susceptible to ocular pathologies later on in life. [42]

Another study done among medical students in Oman, focused on environmental factors which may have been associated with Computer Vision Syndrome such as poor lighting, an imbalance of light between the screen of the computer and the surroundings, resolution, contrast, glare of display screen, refresh rate, and font size. The results showed that more than one fifth of the subjects were convinced that poor lighting and an imbalance of light from the display screen and surroundings caused symptoms of Computer Vision Syndrome. Another study reported adjustments to light had a positive influence and reduced Computer Vision Syndrome. [43]

In a study done among medical students in the University of the West Indies, Jamaica, ergonomic practices and CVS were studied and it was found that the symptoms of Computer Vision Syndrome occurred less by holding the device just below eye level and improved ergonomic practices could reduce the symptoms. [44]

2.5 Quality of life among digital device users

There are not many studies that investigates the quality of life amongst digital device users. However, there is one study noted that observes the quality of life of persons who are digitally connected. Although the information is limited in that aspect, there are various studies which investigate the effect of blue light emitted by such devices on the quality of life of various persons, as well as the association between the use of smartphones and musculoskeletal discomfort felt.

The internet and digital devices are increasingly becoming more important and heavily relied on to provide a means of communication, information gathering, social networking and financial transactions. A study conducted in South Africa, aim at analysing the quality of life of persons digitally connected throughout Gauteng City Region [45]. From the results, it was seen that with controlled factors, persons who are connected digitally had a larger score on the quality of life indicators, compared to those who had no access to digital devices. According to [45] the quality of life of an individual is considered the most important outcome of economic and social inclusion. This study investigated the various domains of quality of life through asking subjects about their; life as a whole, standard of living, health, relationships, work, housing, finances and social marginalization. It was found that residents with digital autonomy showed a higher satisfaction with their quality of life whereas those who were not able to be digitally connected due to digital exclusion lead a lower quality of life. Due to this gap in the quality of life experienced when digitally connected, it can be seen that the lack of digital connectivity can help to halt the social and economic inequalities.

It has been investigated by various studies, how exactly the blue light emitted from digital devices can affect the quality of life of persons. Devices such as tablets, laptops and smartphones has become more widely used within the last decade and can have effects on the social transformation of individuals and impact daily routines or habits due to it becoming an integral part of human life. These devices emit blue light which may have effects on the circadian rhythm. [46]. In a first study done to determine the perception of sleep disturbances due to use Blue-Light Emitting Devices among medical Students [46]. It can be seen that the blue light on these devices when used near bedtime have a negative effect on the sleep due to the stimulation of the light or the excessive use. From the analysis, it was noted that 286 (97.3%) of students used a smart device that emits blue light, at bedtime before sleep. Of those students, 101 (35.3%) stated that they had poor sleep quality. The perception that their sleep was disturbed by night usage of their device was stated by 188 students (65.7%). The mean sleep duration of students obtained during this study was 6.3 hours, where 119 students (63.3%) admitted to fatigue on waking, 76 students (40.4%) presented with poor sleep quality. There is an assumption that impaired sleep can lead to many health-related concerns such as mood disorders, obesity or increased accidents.[46]

Similar to the study above, another study was conducted to investigate how the use of digital media 2 hours before bedtime is associated with sleep variation in university students [47]. University students use digital media for extended times, even near bedtime, which can have a negative effect on the sleep outcome. It is also known that adequate sleep is important for good physical and mental health. In this study, it was seen that an extended duration of media use was related to the total sleep time being reduced and leading to students having a later bedtime.

In addition to the effect of digital devices due to its blue light emitting qualities, it can disrupt the quality of life through musculoskeletal discomfort. In this study, investigators seek to determine the association between use of smartphones and the musculoskeletal discomfort faced by adolescent students at a junior college in Taiwan [48]. The investigators hypothesized that the duration of the smart phone usage would be related to the increased instances of musculoskeletal discomfort in these students. From the analysis, it was seen that almost half the students experienced neck and shoulder discomforts, and the number of areas of the body discomforted increased, with increased time spent on the smartphone using ancillary functions. This was noted, as students who used the phone more than 3 hours a day, had a higher risk of upper back discomfort than those who used the phone for less than 1 hour a day. Most students within this study, used the phone for ancillary functions such as apps which allowed them to browse the net, watch videos or play games, leading them to spend a longer amount of time of these devices. The parts of the body which were stated to have experienced the most pain commonly were; the neck, shoulders, upper back and lower back, due to poor body structures which thereby affect their musculoskeletal system[48]. The degree of influence the smartphone has, was correlated significantly to the number of body parts that faced discomfort with these subjects. Due to typing being the most common action performed with smartphones, this can cause discomfort in the upper limbs such as thumbs, hand, wrist and arm, this can also lead to soft tissue injury of the thumb or generate syndromes such as wrist tendinitis or De Quervain's syndrome[48].

A cross-sectional, observational study was carried out in the month of September of 2020, in which the participants were undergraduate students from Ahmedabad who were using VDTs (Visual Display Terminals) for educational purposes and other activities for more than 6 to 8 months. The results of the study are as follows, a total of 103 undergraduate students responded with a mean age of 19±1.5 years. It found that most students had a screen time which averaged from 4-9 hours a day. The results showed that burning sensation (69.8%), redness (51.4%), itching (47.6%) were the most common symptoms, closely followed by irritation (34.6%) and scratchiness (25.5%) related to dry eyes[49]. While a loss of concentration (73.8%), tired eyes (69.6%),

discomfort (61.2%), headache (60.7%), reduced reading speed (56.3%), fluctuation on vision (44.7%), blurring (43.7%), were the most common symptoms related to near work on computers[49]. Also double vision (25.2%) and floating of objects (11.7%) were found to be the least common symptoms related to near work [49]. The researchers concluded computer related vision symptoms were increasing during the COVID-19 era. It was also stated that increasing awareness, taking regular breaks, avoiding unnecessary web searching and social media can help to decrease and relieve symptoms associated with computer use in the COVID-19 area[49].

A study was done on the impact of the COVID-19 lockdown on digital device-related ocular health which was conducted through an online survey which was open for a period of 2 weeks. There were a total of 407 responses; the average age of the respondents was 27.4 years. 93.6 % of respondents reported an increase in the use of digital devices since the lockdown. The average increase was found to be 4.8 ± 2.8 hours per day with the total usage per day being 8.65 ± 3.74 hours. 62.4% of respondents reported sleep disturbances due to the increased screen time. Typically, 95.8% of respondents experienced at least one symptom related to digital device use and 56.5% said that the frequency and intensity of these symptoms increased since the lockdown. The most common symptoms of digital eye strain were reported to be headache (43.5%), eye pain (29.0%), heavy eyelids (23.8%), redness (23.1%), watering of eyes (23.1%) and burning (22.9%). While the least common symptoms were feeling a foreign body (8.1%), double vision (5.7%) and seeing coloured rings around bright lights (4.9%)[50]. The researchers also reported that sleep pattern disturbances were more frequent in persons who reported a longer screen time. The researchers concluded that there was a slow deterioration of ocular health across all age groups due to increase in use of digital devices [50].

Additional Article:

An article written in March of 2021 titled “Online classes causing eye problems in children” was featured in the Trinidad and Tobago Newsday website [51]. The article details interviews with several people including teachers, parents, opticians and optometrists on how COVID-19 has affected ocular health in children due to digital device use. From the article some of the most common complaints expressed by the children were tired

and burning eyes, dry eyes and headaches. Some children also complained of back and neck pains from extensive use of these digital devices.

Chapter 3

Methodology

3.1 - ETHICAL CONSIDERATION

CREC-SA.0712/01/202 Permission was granted by the UWI Optometry Unit to firstly conduct research on this particular topic. A research proposal was submitted along with a formally completed consent form to the scientific research ethical committee for approval prior to collecting data for the study and approval was given. The reference number for the UWI ethics committee was CREC-SA.0712/01/202. A cover letter stating that the confidentiality of information given on the questionnaire will not be breached was included and so confidentiality was maintained.

The schools that were randomly chosen were sent letters requesting permission to conduct the survey among the students in their schools. Some of the schools agreed, while some declined and each school's decision was respected. The schools which agreed to allow us to conduct the survey among their students were sent the consent forms and were informed of the purpose of the study as well as the non-invasiveness and painless procedure of the survey.

Written consent was required, as most of the participants were under the legal age of 18, and therefore required the permission of a parent or guardian to participate. However, an assent form was attached to that consent form to ensure that the participant, although not of legal age, understood what they agreed to participate in and how their information would be used. For students over the age of 18, there was a separate consent form, where they gave permission for themselves to participate.

There was no request for waiver of consent, as this research proceeded practically without the need of waiver. The participants were also informed of the confidentiality of the data as the questionnaire was done

anonymously and the data collected was secured in a highly secured laptop, only accessible by the principal investigator and the co-investigators involved in this project.

There were no names taken during this research, nor used for analyzing data. No specific identifiable information about the participants was used. When the statistical data is shared to bring awareness about the findings, there would be no information on any participant.

There was no more than minimal risk. This therefore means that the risk that can be associated with this research, is no greater than those risks that may be encountered during everyday activities. A risk can be encountered at any time however there are not many known risks associated with the research.

Some risks may be; discomfort (physical/psychological) of having to sit and answer the questionnaire and time loss, as it required ten (10) minutes of the participant's time to fill out the data required.
There were no financial risks of this research and no compensation for participants.

3.2 RESEARCH DESIGN

This study uses a quantitative observational cross-sectional approach amongst secondary school students of Trinidad, with the use of a structured questionnaire. The questionnaire was firstly tested and re-tested in a pilot study containing ten (10) students who did not take part in the actual research study. The questionnaire assessed the demographics, current study status, digital device usage, visual ergonomics, pattern of ocular complaints, responsiveness to ocular complaints, nature of management of ocular complaints, and the effect on the student's health and how it has affected their life. The results of the responses were then analysed so that the findings would bring awareness about the effects that online learning is having on secondary school students which could

lead to optometrists being able to help relieve the symptoms, which will allow students to be more productive and efficient while continuing with online learning, or perhaps even in the future, with the continued use of digital devices.

3.3 - STUDY POPULATION

This study targeted students between the ages of 12 to 19 years, who attend secondary schools throughout Trinidad. The level of study of each student and the age of the student was considered. All races, ethnicities and genders were included. Students were recruited to do these surveys through their respective schools. The principal or a teacher of the school was informed of the research and was required to choose the students to participate and contact their respective parents to ensure consent. Consent was confirmed through the consent form sent by their teachers or principal.

Participants chosen for this study were done in a random format, such that there was a possibility that a student who was chosen may not be experiencing any ocular symptoms or have any ocular complaints due to the remote learning to lessen the bias.

3.3.1 - STUDY SITE OR AREA OF STUDY

The study area is the seven (7) districts throughout Trinidad namely, Caroni, North Eastern, Port of Spain and environs, South Eastern, St. George East, St.Patrick and Victoria. The district of Caroni is located in the western-central part of Trinidad. Historically, it was associated with sugar cane and rice lands due to the flat land. The Caroni Bird Sanctuary, the Caroni Swamp and the Caroni River are some of the main attractions in this district. Caroni encompasses some of the towns like Chaguanas, Couva and Cunupia. This district can be considered

more urban than rural in its nature due to the many businesses and developments especially within the recent times.

The district of North Eastern, as the name suggests, is located in the north-eastern part of Trinidad. This district can be considered more rural in nature as there are also a lot of areas lining the coast. The Caribbean Sea and the Atlantic Ocean are located north and east of that district respectively. Some of the most commonly known areas in the north eastern distinct are Sangre Grande, La Horqueta and Manzanilla.

The district of Port-of-Spain and environs is located on the north-west coast of Trinidad. Port-of-Spain is the capital city of the country and has the second largest population. Port-of-Spain and environs can be more urban in nature as this is the administrative centre of the island. It has the largest container port, the Parliament and many hotels, skyscrapers, restaurants, and businesses. This district is commonly known for its nightlife and entertainment. Some of the commonly known places in this district are Woodbrook, Saint James, and Belmont.

The district of South Eastern, as the name suggests, is in the south eastern part of Trinidad. It can be more rural in nature as it is also located on the coast and is commonly known for its farming and hunting. Some of the most known towns in this district are Rio Claro, Princes Town and Mayaro.

The district of St. George East is in the eastern part of the island. Some of the most commonly known towns are San Juan, El Dorado and St.Augustine. This can be considered urban in nature as there are many businesses, restaurants, and The University of the West Indies is in this district. There are other tertiary level institutions located in this district as well as secondary and primary.

The district of St.Patrick is located in the south-westers part of Trinidad. Some of the common towns are Point Fortin, La Brea and Siparia. There are both urban and rural parts of this district and it cannot be classified as

one more than the other. This district contains the pitch lake which is the largest natural deposit of asphalt in the world.

The district of Victoria is in the southern part of the island. It can be considered urban in nature as it is home to the largest city in Trinidad, San Fernando. Some of the other towns in this district include Naparima, Gasparillo and Marabella. There are many businesses, restaurants and malls in this district.

3.3.2 - INCLUSION CRITERIA

The candidates included secondary school students aged twelve (12) to nineteen (19) years, who are citizens of Trinidad and have been living in Trinidad for the last year and did online learning due to Covid-19. Students of all races, genders and ethnic composition are also included in this study.

3.3.3 - EXCLUSION CRITERIA

The candidates excluded secondary school students who were not between the ages of twelve (12) to nineteen (19) years, immigrant secondary school students who did not have citizenship, secondary school students who did not live in Trinidad for the past year, visually impaired (blind) secondary school students, and non-English speaking secondary school students were unfortunately excluded from this study

3.4 - SAMPLE SIZE AND SAMPLING TECHNIQUE

3.4.1 - SAMPLE SIZE DETERMINATION

The study ensured that an adequate sample is obtained from the study population. Given that Trinidad has approximately 141 secondary schools, each with an average of 450 students, the population size of this study

would be 63,450 students [52]. A confidence interval of 95% and a margin of error of 5% the sample size is calculated to be 382. The sample size was determined using the RAOSOFT sample size calculator.

Originally, the total number of surveys needed were approximately 400 which was then divided among the 7 districts of Trinidad and resulted in 57.1 participants. Therefore, that number was rounded up and, 60 students per school were supposed to be given the surveys and this was supposed to be further divided into the 6 different forms/grades which would have resulted in 10 students per form/grade. The numbers were rounded up in case some of the students did not respond to the survey or did not get consent from their parents.

Unfortunately, due to some schools declining in certain districts, multiple schools within the same district were given the questionnaire and it was not uniformly done with the same number of participants for each form/grade. More than 400 responses were collected which resulted in a total of 435.

3.4.2 - SAMPLING TECHNIQUE

This study uses a random sampling method. A well-constructed questionnaire was put together by the researchers that will seek to collect data for the study. The build-up of the questionnaire was based on the specific objectives, purpose and aim of the study. The questionnaires along with the consent forms were sent to teachers and principals of various secondary schools in Trinidad via email and by the use of instant messaging. The teachers and principals then distributed the questionnaires and consent forms to their students. This was done to ensure that each student had an equal chance of being selected to reduce the bias that may have occurred wherein which a child may have been selected regardless of whether they presented with the symptoms or not.

3.5 - TESTS AND INSTRUMENTS/EQUIPMENT

3.5.1 DATA COLLECTION INSTRUMENT

A well-constructed questionnaire was put together on Google Forms by the researchers that was used to collect data for the study. The questionnaire is based on the specific objectives, purpose and aim of the study. Each questionnaire was estimated to take at least 10 minutes to complete.

The following are the sections in which the questionnaire was structured:

Section 1: Demographic data. Gathering of general information of the participants. (Age, Gender, Ethnicity, Community type)

Section 2: Current study status. (The class the person is in, type of schooling done before and during COVID 19, how teaching is delivered online)

Section 3: Digital Device Usage. (What kind of a digital device the participant uses and the duration of usage)

Section 4: Visual Ergonomics. (Preferred position while using digital device and duration of preferred position)

Section 5: Pattern of ocular complaints. (Symptoms and the severity of those symptoms)

Section 6: Response to ocular complaints. (What the participants did to relieve the symptoms)

Section 7: Nature of management. (What the nature of the treatment was and if it the participant was satisfied with it)

Section 8: Effect on health and how it has affected life.

3.5.2 ADMINISTRATION OF DATA COLLECTION INSTRUMENTS

The investigator and co-investigators underwent practical training to be equipped with basic knowledge, attitude and skills for data collection. Pre-testing of the questionnaire was done to improve the tool and prepare the researchers for data collections as briefing sessions was done to discuss the challenges faced during pre-testing exercise to ensure the quality of data was not compromised.

3.5.3 RELIABILITY AND VALIDITY

Before the instruments were administered to the main respondents, its reliability was established, and it was validated via the Cronbach's Alpha coefficient via the use of Statistical Package for Social Sciences (SPSS) and the Content Valid Index (CVI) respectively.

3.5.3.1 RELIABILITY OF THE INSTRUMENTS

As the questionnaire was constructed by the researcher, the estimation of reliability was ascertained by pilot testing the instrument and applying Cronbach's Alpha coefficient by means of a Statistical Package for Social Sciences. Cronbach's Alpha coefficient was used to measure internal consistency of the research tool. Cronbach's Alpha Coefficient was 0.79 which is greater than 0.7, indicating the instrument was considered reliable.

3.5.3.2 VALIDITY OF THE INSTRUMENTS

The researchers with the help of supervisors discussed the questionnaires with basing on the Content Valid Index (CVI) which is a scale developed by computing or rating the relevant items in the instrument or questionnaire by checking their clarity, their meaningfulness in line with all objectives stated, dividing by the total number of items. These instruments were then passed onto the supervisors for further scrutiny before being administered in the field.

3.6 - DATA COLLECTION PROCEDURE

In this study the choice of data collection methods had been influenced by the data collection strategy, the type of variable, the accuracy required, the collection point and the skill of the enumerator. Links between a variable, its source and practical methods for its collection.

A random selection website was used to choose the specific schools within the seven (7) districts of; Caroni, North Eastern, Port of Spain and environs, South Eastern, St. George East, St.Patrick and Victoria in Trinidad. Then, permission to conduct the research was acquired from the various schools. The principals and teachers were contacted by the researchers via email, phone calls and instant messaging to seek their permission to distribute the questionnaires to their students accordingly.

Next, the consent forms and assent forms for the students under the age of eighteen were also sent via email and instant messaging along with the link to participate in the questionnaire as well as an email which explained the procedure, the purpose, the very minimal risk, and the lack of compensation. There was a constant follow-up with the schools which occurred via email , instant messaging and phone calls, to ensure the questionnaires were completed.

3.7 - DATA ANALYSIS PROCEDURE

Descriptive statistics was used to give a clear picture of background variables like age, sex and other variables in a well-structured questionnaire. The frequency distribution of both dependent and independent variables was used. The association between variables was measured and tested using chi square. A P-value < 0.05 was considered to be statistically significant in all cases. The data was analyzed and interpreted in the baseline of the objectives of this study, where the data was coded and entered into the computer by using Statistical Package for Social Scientist (SPSS.).

Descriptive statistics helped a researcher to summarize a sample, rather than use data to learn about the population that the sample of data is thought to represent, it also helped to set brief descriptive coefficients than summarizes a given data set that represents the entire population. Multi-variance logistic regression analysis (ODD RATIO) was used in generating descriptive data for continuous variables and frequencies and for many simultaneous confounding variables.

Collected data were summarized and presented in form of rates, proportions, tables, graphs, narrative, and inferential comparisons will be used.

With collection of data completed, all data was sent into the Statistical Package for the Social Sciences (SPSS) and then evaluated. Statistical data was generated (frequencies, Standard deviations and mean) and a detailed report of the patterns of ocular complaints among students during remote learning.

Chapter 4

Results

4.1 Demographics

The majority of participants in the study were of the male gender. The majority of participants subjectively classified themselves ethnically as Indo-Trinidadians. The most popular age group among participants were between the ages of 14-15 years old. The majority of participants also resided in an urban area. The most amount of participants was from the Form 3 class group.

Table 2 showing all of the demographic data collected from secondary school students that participated in the study.

Characteristic	***Number of Participants (%)***
Population Demographics	
Sex	
Male	220 (50.5)
Female	206 (47.3)
Prefer not to say	9 (2.1)
Ethnicity	
Afro - Trinidadian	73 (16.8)
Indo - Trinidadian	214 (49.2)
Syrian/Lbanese	1 (0.2)
Mixed	108 (24.8)
Other	40 (9.0)

Age (years)	
12-13	70 (16.1)
14-15	196 (45.1)
16-17	111 (25.5)
18-19	58 (13.3)
Nature of community	
Rural area	179 (41.1)
Urban area	256 (58.9)
Form/Class/Grade Level	
1	23 (5.3)
2	95 (21.8)
3	118 (27.1)
4	75 (17.2)
5	53 (12.2)
6	71 (16.3)

Table 2 shows that the majority of participants belonged to the male gender (50.5%), the largest ethnic group represented was that of Indo-Trinidadians (49.2%), the most popular age range was between the ages of 14-15 years old (45.1%), and the most common nature of community participants resided in was urban in nature (58.9%). Additionally, majority of the participants belonged to the Form 3 (27.1%) level.

4.2 Pattern of Ocular Complaints

Headaches were the most common ocular symptom found in both males (74.1%) and females (57.3%). A distinct increase was noticed in the number of participants who suffered from these ocular complaints during the period of Covid-19 as compared to before Covid-19. However, majority of all the ocular complaints were rated as 1 out of 10, indicating that it was not very severe.

Table 3: The relationship between gender and the ocular complaint of headaches among secondary school students that participated in the study.

		Currently experience headaches with the use of your digital device				
		Yes		**No**		**Total**
		Frequency	**%**	**Frequency**	**%**	
Gender	**Female**	118	57.3	88	42.7	206
	Male	163	74.1	57	25.9	220

Table 3 does not account for the nine (9) participants who preferred not to specify their gender and hence the total participants accounted for is four hundred and twenty-six (426). It can be seen that males experienced more headaches than females while using their digital devices.

Table 4: The relationship between gender and the ocular complaint of dry/gritty eyes among secondary school students that participated in the study.

		Currently experience dry/gritty eyes with the use of your digital device				
		Yes		No		Total
		Frequency	%	Frequency	%	
Gender	**Female**	79	38.3	127	61.7	206
	Male	110	50	110	50	220

Table 4 does not account for the nine (9) participants who preferred not to specify their gender and hence the total participants accounted for is four hundred and twenty-six (426). It can be seen that males experienced more dryness of the eyes than females while using their digital devices.

Table 5: The relationship between gender and the ocular complaint of itchy eyes among secondary school students that participated in the study.

		Currently experience itchy eyes with the use of your digital device				
		Yes		No		Total
		Frequency	%	Frequency	%	
Gender	**Female**	63	30.6	143	69.4	206
	Male	95	43.2	125	56.8	220

Table 5 does not account for the nine (9) participants who preferred not to specify their gender and hence the total participants accounted for is four hundred and twenty-six (426). It can be seen that males experienced more itchiness of the eyes than females while using their digital devices.

Table 6: The relationship between gender and the ocular complaint of blurry vision among secondary school students that participated in the study.

		Currently experience blurry vision with the use of your digital device				
		Yes		No (%)		Total
		Frequency	%	Frequency	%	
Gender	**Female**	69	33.5	137	66.5	206
	Male	119	54.1	101	45.9	220

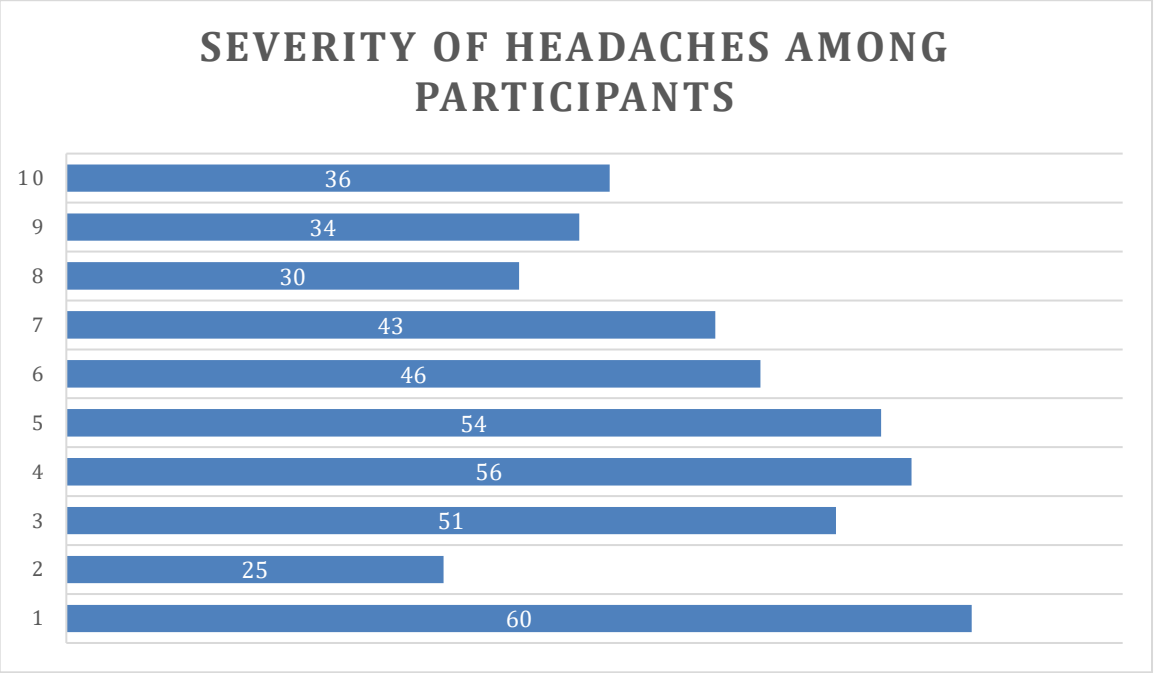
Table 6 does not account for the nine (9) participants who preferred not to specify their gender and hence the total participants accounted for is four hundred and twenty-six (426). It can be seen that males experienced blurry vision more than females while using their digital devices.

Table 7: The relationship between gender and the ocular complaint of double vision among secondary school students that participated in the study.

		Currently experience double vision with the use of your digital device				
		Yes		No		Total
		Frequency	%	Frequency	%	
Gender	**Female**	31	15	175	85	206
	Male	53	24.1	167	75.9	220

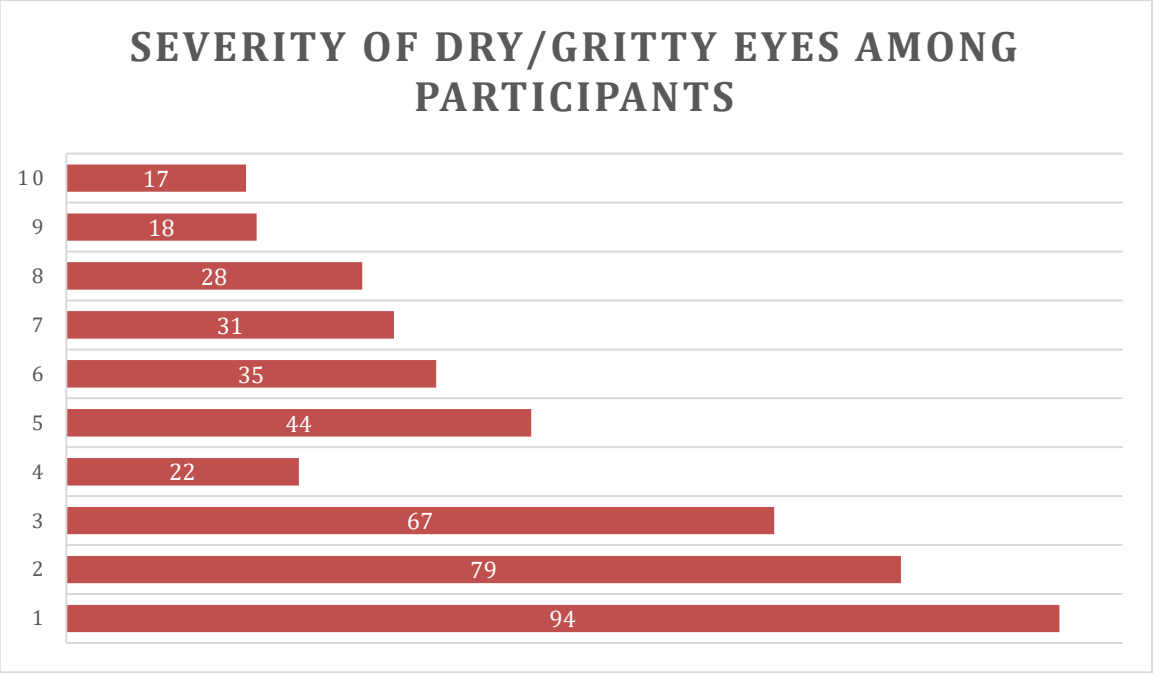
Table 7 does not account for the nine (9) participants who preferred not to specify their gender and hence the total participants accounted for is four hundred and twenty-six (426). It can be seen that males experienced double vision more than females while using their digital devices.

Figure 2: Bar Graph showing the severity of headaches among secondary school students that participated in the study.



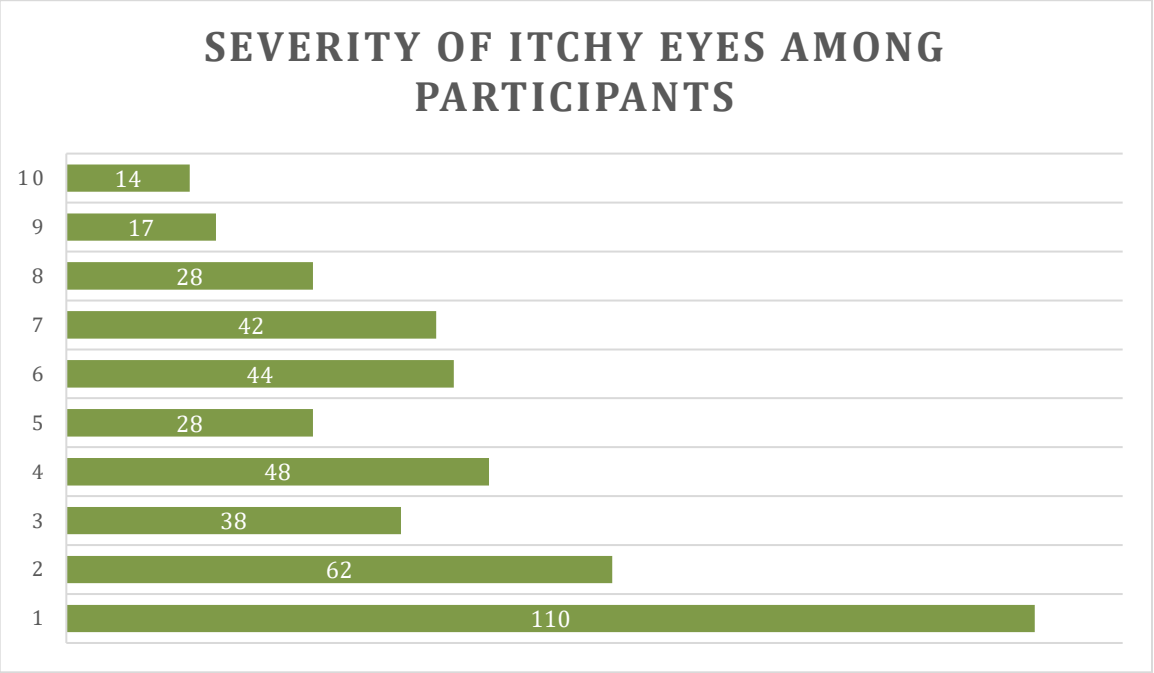
From the illustration above, it is observed that the majority of the participants (60) ranked the severity of their headaches as 1 out of 10 indicating that it was not very severe.

Figure 3: Bar graph showing the severity of dry/gritty eyes among secondary school students that participated in the study.



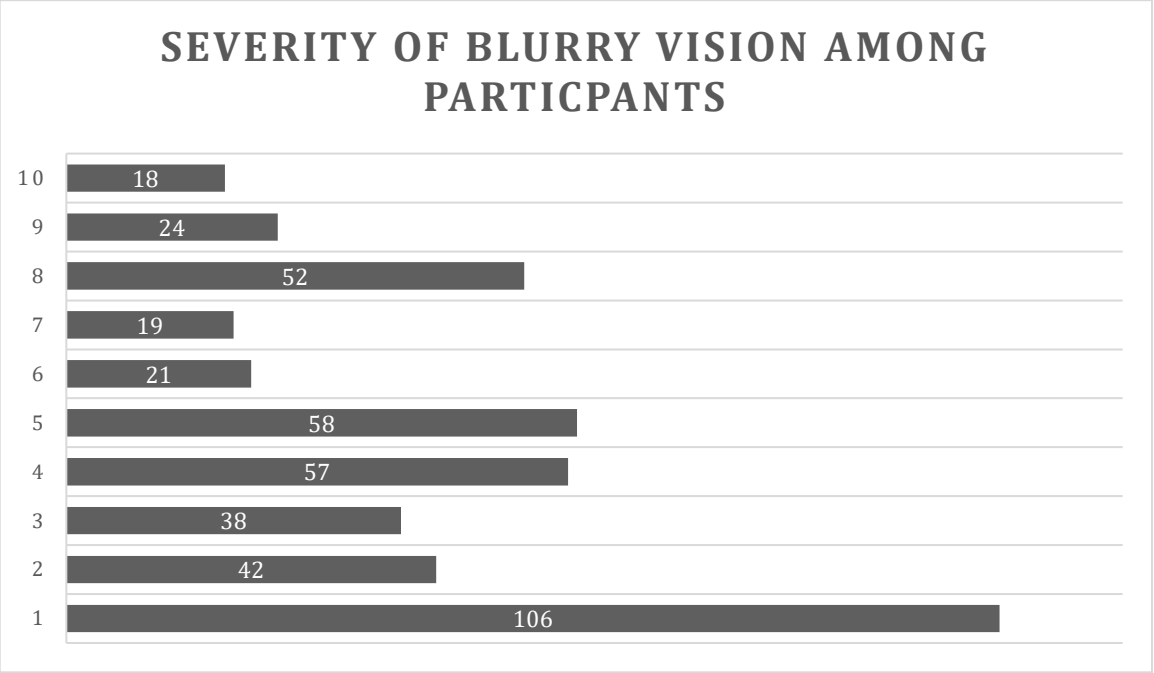
From the illustration above, it is observed that majority of the participants (94) ranked the severity of their dry/gritty eyes as 1 out of 10 indicating that it was not very severe.

Figure 4: Bar graph showing the severity of itchy eyes among secondary school students that participated in the study.



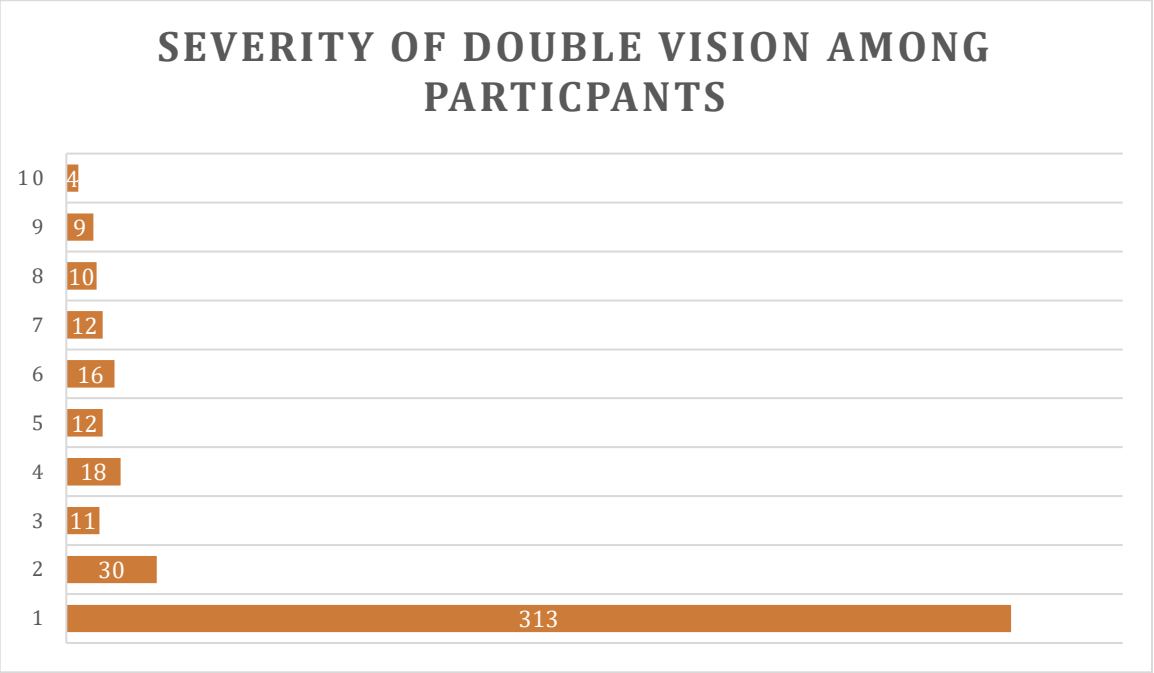
From the illustration above, it is observed that majority of the participants (110) ranked the severity of their itchy eyes as 1 out of 10 indicating that it was not very severe.

Figure 5: Bar graph showing the severity of blurry vision among secondary school students that participated in the study.



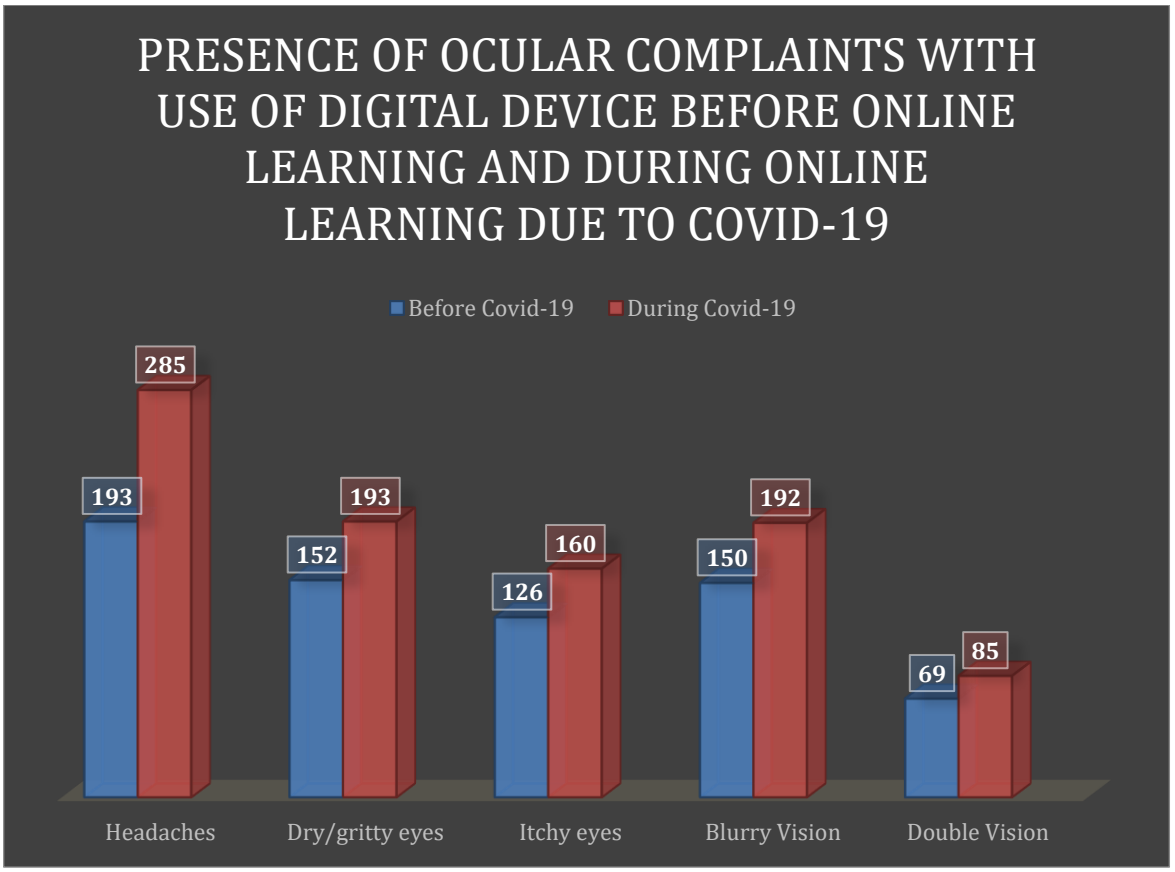
From the illustration above, it is observed that majority of the participants (106) ranked the severity of their blurry vision as 1 out of 10 indicating that it was not very severe.

Figure 6: Bar graph showing the severity of double vision among secondary school students that participated in the study.



From the illustration above, it is observed that majority of the participants (313) ranked the severity of their double vision as 1 out of 10 indicating that it was not very severe.

Figure 7: Column graph showing the presence of the various ocular complaints before Covid-19 and during Covid-19 among secondary school students that participated in the study.



From the illustration above, it is clearly observed that each of the ocular complaints among secondary school students was increased during the period of Covid-19 as compared with before Covid-19.

4.3 Factors contributing to ocular complaints

The participants who spent more than 6 hours on their digital devices were more likely to experience headaches (71.8%) and dry/gritty eyes (54.5%). The majority of participants (66.7%) experienced all five ocular symptoms while in the laying down position. The majority of students that belonged to Forms 5 and 6 spent more time on their digital devices than students from the other forms.

Table 8: The relationship between duration of time spent using a digital device and the presence of headaches among secondary school students that participated in the study.

Duration of day spent on digital device	Presence of headaches				Total
	Yes		No (%)		
	Frequency	%	Frequency	%	
Less than 1 hour	8	61.5	5	38.5	13
1 – 2 hours	9	50	9	50	18
2 – 4 hours	19	51.4	18	48.6	37
4 – 6 hours	170	66.1	87	33.9	257
More than 6 hours	79	71.8	31	28.2	110

Table 8 shows that the majority of students spent between 4 – 6 hours on their digital devices and also had the highest number of students who complained about the presence of headaches during that time spent on their digital devices. Overall, the presence of headaches outweighed the absence of it.

Table 9: The relationship between duration of time spent using a digital device and the presence of dry/gritty eyes among secondary school students that participated in the study.

Duration of day spent on digital device	Presence of dry/gritty eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Less than 1 hour	3	23.1	10	76.9	13
1 – 2 hours	4	22.2	14	77.8	18
2 – 4 hours	11	29.7	26	70.3	37
4 – 6 hours	115	44.7	142	55.3	257
More than 6 hours	60	54.5	50	45.5	110

Table 9 shows that the most amount of time spent on the digital device by the secondary school students were between 4 – 6 hours, however, they did not experience dry/gritty eyes. Rather, the majority of the students who spent more than 6 hours on their digital devices complained of dry/gritty eyes.

Table 10: The relationship between duration of time spent using a digital device and the presence of itchy eyes among secondary school students that participated in the study.

Duration of day spent on digital device	Presence of itchy eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Less than 1 hour	5	38.5	8	61.5	13
1 – 2 hours	1	5.6	17	94.4	18
2 – 4 hours	10	27	27	73	37
4 – 6 hours	95	37	162	63	257
More than 6 hours	49	44.5	61	55.5	110

Table 10 shows that there was an overall absence of itchy eyes present among the secondary school students that participated in the study regardless of the length of time spent using their digital devices.

Table 11: The relationship between duration of time spent using a digital device and the presence of blurry vision among secondary school students that participated in the study.

Duration of day spent on digital device	Presence of blurry vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Less than 1 hour	4	30.8	9	69.2	13
1 – 2 hours	9	50	9	50	18
2 – 4 hours	16	43.2	21	56.8	37
4 – 6 hours	111	43.2	146	56.8	257
More than 6 hours	52	47.3	58	52.7	110

Table 11 shows that there was an overall absence of blurry vision present among the secondary school students that participated in the study regardless of the length of time spent using their digital devices.

Table 12: The relationship between duration of time spent using a digital device and the presence of blurry vision among secondary school students that participated in the study.

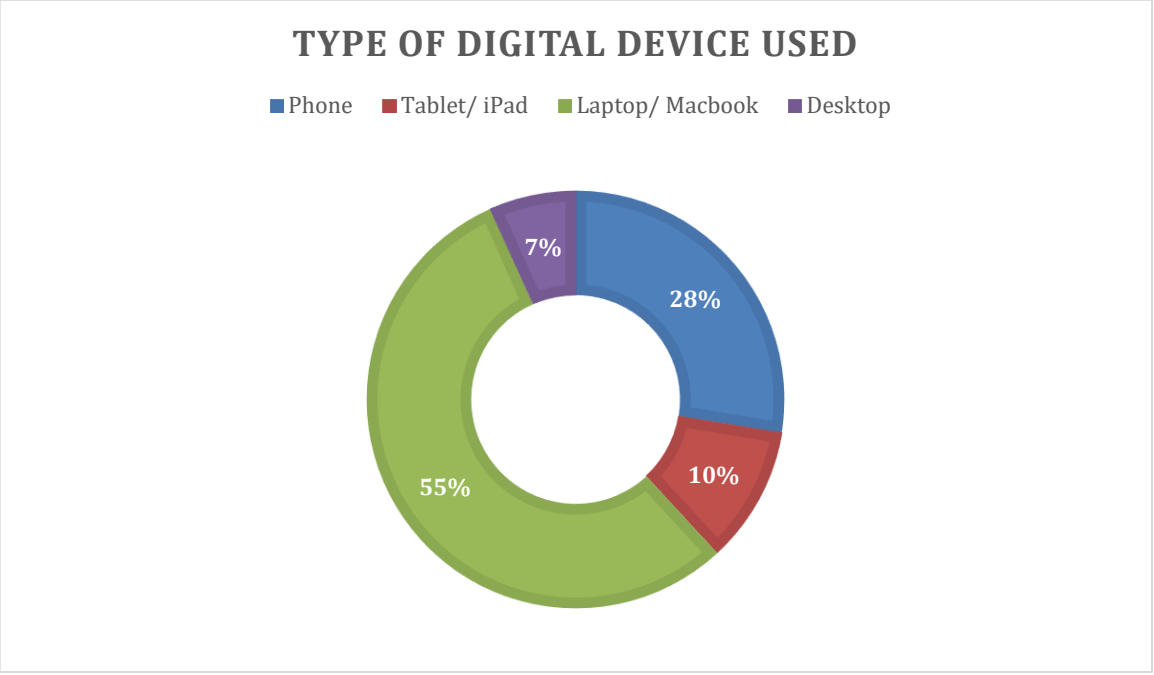
Duration of day spent on digital device	Presence of double vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Less than 1 hour	2	15.4	11	84.6	13
1 – 2 hours	6	33.3	12	66.7	18
2 – 4 hours	4	10.8	33	89.2	37
4 – 6 hours	42	16.3	215	83.7	257
More than 6 hours	31	28.2	79	71.8	110

Table 12 shows that there was an overall absence of double vision present among the secondary school students that participated in the study regardless of the length of time spent using their digital devices.

Digital device usage among students

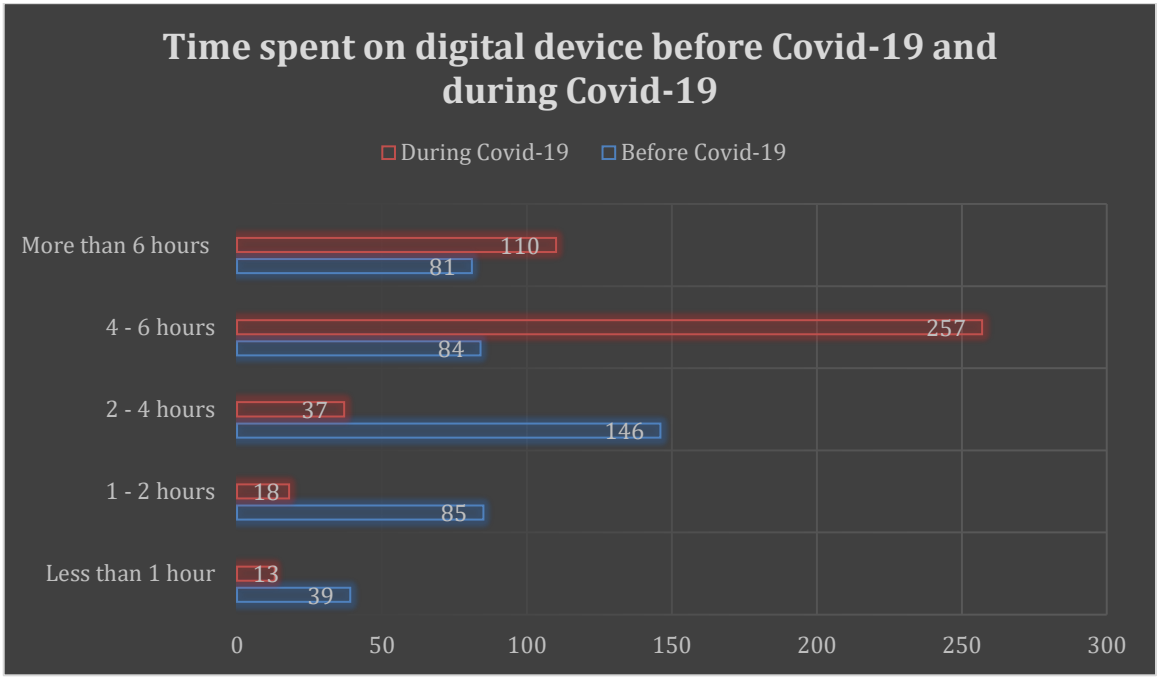
The most common digital deice to be used among participants was a laptop/Macbook. Overall, there was a sharp increase in the longer hours spent using digital devices during the period of Covid-19 as compared to before Covid-19.

Figure 8: Doughnut pie-chart showing the type of digital device used among secondary school students that participated in the study.



From the illustration above, it is observed that the majority of students used a laptop or Macbook (55%) and the least used digital device was a desktop (7%).

Figure 9: Clustered bar graph showing the time secondary school students that participated in the study spent before Covid-19 and during Covid-19.



From the illustration above, it can be clearly seen that that students spent less time on their devices before COVID-19, whereas due to COVID-19, the number of students who spent more time on their devices increased.

Table 13: The relationship between the preferred position while using the digital device and the presence of headaches among secondary school students that participated in the study.

Preferred position while using digital device	Presence of headaches				Total
	Yes		No		
	Frequency	%	Frequency	%	
Sitting	203	64.2	113	35.8	316
Standing	42	76.4	13	23.6	55
Laying down	2	66.7	1	33.3	3
Other	38	62.3	23	37.7	61

Table 13 shows that the majority of people preferred the sitting position and also experienced headaches while in that position.

Table 14: The relationship between the preferred position while using the digital device and the presence of dry/gritty eyes among secondary school students that participated in the study.

Preferred position while using digital device	Presence of dry/gritty eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Sitting	128	40.5	188	59.5	316
Standing	37	67.3	18	32.7	55
Laying down	2	66.7	1	33.3	3
Other	26	42.6	35	57.4	61

Table 14 shows that the majority of the students that participated in the study who preferred standing and laying down experienced dry/gritty eyes, however, overall, the most preferred position was sitting and there was an absence of dry/gritty eyes among participants.

Table 15: The relationship between the preferred position while using the digital device and the presence of itchy eyes among secondary school students that participated in the study.

Preferred position while using digital device	Presence of itchy eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Sitting	110	34.8	206	65.2	316
Standing	28	51	27	49	55
Laying down	2	66.7	1	33.3	3
Other	20	32.8	41	67.2	61

Table 15 shows that the majority of the students that participated in the study who preferred the standing and laying down position experienced itchy eyes as compared to the majority of participants who preferred the sitting position and did not experience itchy eyes.

Table 16: The relationship between the preferred position while using the digital device and the presence of blurry vision among secondary school students that participated in the study.

Preferred position while using digital device	Presence of blurry vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Sitting	130	41.1	186	58.9	316
Standing	30	54.5	25	45.5	55
Laying down	2	66.7	1	33.3	3
Other	30	49.2	31	50.8	61

Table 16 shows that the majority of the students that participated in the study who preferred the standing and laying down position experienced blurry vision, however, overall, the majority of students preferred sitting and the majority also did not experience blurry vision.

Table 17: The relationship between the preferred position while using the digital device and the presence of double vision among secondary school students that participated in the study.

Preferred position while using digital device	Presence of double vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Sitting	55	17.4	261	82.6	316
Standing	17	31	38	69	55
Laying down	2	66.7	1	33.3	3
Other	11	18	50	82	61

Table 17 shows that there is an overall absence of the presence of double vision among the students that participated in the study, however, the number of students who preferred the laying down position experienced double vision was higher than those who did not experience double vision, although not significantly.

Table 18: The relationship between the duration of time spent using digital devices and the Form/Grade/Class of the secondary school student that participated in the study.

Duration of time spent on digital device	Form/ Grade/ Class												Total
	Form 1		Form 2		Form 3		Form 4		Form 5		Form 6		
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%	
Less than 1 hour	1	7.7	6	46.1	4	30.8	2	15.4	0	0	0	0	13
1 – 2 hours	1	5.6	5	27.8	8	44.4	2	11.1	2	11.1	0	0	18
2 – 4 hours	1	2.7	15	40.6	11	29.7	8	21.6	1	2.7	1	2.7	37
4 – 6 hours	18	7	57	22.2	71	27.6	40	15.6	25	9.7	46	17.9	257
More than 6 hours	2	1.8	12	11	24	21.8	23	20.9	25	22.7	24	21.8	110

Table 18 shows that the majority of the students in Form 6 spent more time on their devices followed by the students in Form 5 which can be due to them having exams and hence spending more time revising on their digital devices now that schooling is done online.

4.4 Responsiveness to ocular complaints:

The majority of students did nothing to resolve all of their ocular complaints.

Table 19: The relationship between what was done to relieve the symptoms experienced and the presence of headaches among secondary school student that participated in the study.

What was done to resolve the symptoms experienced	Presence of headaches				Total
	Yes		No		
	Frequency	%	Frequency	%	
Nothing	175	57.6	129	42.4	304
Take breaks	51	87.9	7	12.1	58
Glasses	6	85.7	1	14.3	7
Visited the doctor	6	75	2	25	8
Medication	33	78.6	9	21.4	42
Other	14	87.5	2	12.5	16

Table 19 shows that the majority of students who suffered from headaches did nothing to resolve it.

Table 20: The relationship between what was done to relieve the symptoms experienced and the presence of dry/gritty eyes among secondary school student that participated in the study.

What was done to resolve the symptoms experienced	Presence of dry/gritty eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Nothing	123	40.5	181	59.5	304
Take breaks	34	58.6	24	41.1	58
Glasses	2	28.6	5	71.4	7
Visited the doctor	5	62.5	3	37.5	8
Medication	19	45.2	23	54.8	42
Other	10	62.5	6	37.5	16

Table 20 shows that the majority of students who suffered from dry eyes/gritty eyes did nothing to resolve it.

Table 21: The relationship between what was done to relieve the symptoms experienced and the presence of itchy eyes among secondary school student that participated in the study.

What was done to resolve the symptoms experienced	Presence of itchy eyes				Total
	Yes		No		
	Frequency	%	Frequency	%	
Nothing	101	33.2	203	66.8	304
Take breaks	28	48.3	30	51.7	58
Glasses	1	14.3	6	85.7	7
Visited the doctor	4	50	4	50	8
Medication	18	42.9	24	57.1	42
Other	8	50	8	50	16

Table 21 shows that the majority of students who suffered from itchy eyes did nothing to resolve it.

Table 22: The relationship between what was done to relieve the symptoms experienced and the presence of blurry vision among secondary school student that participated in the study.

What was done to resolve the symptoms experienced	Presence of blurry vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Nothing	119	39.1	185	60.9	304
Take breaks	38	65.5	20	34.5	58
Glasses	3	42.9	4	57.1	7
Visited the doctor	6	75	2	25	8
Medication	16	38.1	26	61.9	42
Other	10	62.5	6	37.5	16

Table 22 shows that the majority of students who suffered from blurry vision did nothing to resolve it.

Table 23: The relationship between what was done to relieve the symptoms experienced and the presence of double vision among secondary school student that participated in the study.

What was done to resolve the symptoms experienced	Presence of double vision				Total
	Yes		No		
	Frequency	%	Frequency	%	
Nothing	48	15.8	256	84.2	304
Take breaks	22	37.9	36	62.1	58
Glasses	0	0	7	100	7
Visited the doctor	2	25	6	75	8
Medication	8	19	34	81	42
Other	5	31.3	11	68.7	16

Table 23 shows that the majority of students who suffered from double vision did nothing to resolve it.

4.5 Impacts of ocular complaints on the quality of life

The majority of participants (37%) did not experience any difference on their quality of life, however, the second largest majority (32.6%) had a severe impact on their quality of life.

Table 24: The relationship between the duration of time spent using the digital device and the impact of ocular complaints on the quality of life among secondary school students that participated in the study.

Duration of time spent on digital device	**Impact of ocular complaints on the quality of life**								**Total**
	No difference		**Barely any effect**		**Moderate effect**		**Severe effect**		
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	
Less than 1 hour	5	35.7	1	7.1	5	35.7	3	21.5	14
1 – 2 hours	10	55.6	3	16.7	2	11.1	3	16.6	18
2 – 4 hours	19	50	5	13.2	7	18.4	7	18.4	38
4 – 6 hours	93	36.5	30	11.8	53	20.8	79	30.9	255

More than 6 hours	34	30.9	13	11.8	13	11.8	50	45.5	110

Table 24 shows that the majority of the people did not notice any difference on the impact of their quality of life, however, the second majority said that their lives were affected severely.

CHAPTER 5

Discussion

In this study we investigated the pattern and responsiveness to ocular complaints among secondary school students learning remotely during COVID 19 in Trinidad. The study was chosen because of the transition from physical learning to remote learning, due to the emergence of the new strain of coronavirus, Sars-Cov-2. This new strain was easily spread throughout various countries, which lead to a pandemic and therefore drastic changes in the modes of interactions among humans in different parts of the globe.

The targeted population for this study was secondary school students between the ages of 12-19, whom are citizens of Trinidad and Tobago, or, if not citizens, have been living within Trinidad for the past year. Initially, this research began as purposive, where schools from the seven (7) districts throughout Trinidad such as, Caroni, North Eastern, Port of Spain and environs, South Eastern, St. George East, St. Patrick and Victoria, were chosen to be investigated. However, due to lack of responses as well as declination from several schools, we then switched the testing to random in order to reach a larger audience spread throughout Trinidad. Questionnaires were generated and sent to school principles and parents, along with consent forms to be filled out and returned to ensure permission for the child's participation. This study was done quantitatively and responses from questionnaires analyzed using the Statistical Package for the Social Sciences (SPSS) software

5.11 DEMOGRAPHICS

This study consisted of 435 participants, from various schools within Trinidad.

From **Table 2**, of all the participants, the majority were males 50.6%, with females being 47.3% and the remaining 2.1% preferred not to state their gender. It was also seen that the majority of the secondary school students, 45.1%, were within the age range of 14 – 15 years old, with the least amount of secondary school students, 13.3%, within the range of 18 - 19 years old.

Table 2 shows the ethnicities of the responders. The participants were mainly of Indo-Trinidadian ethnicity, with a percentage of 49.2%, whereas those of mixed ethnicities was 24.8% , followed by a 16.8% being Afro-Trinidadians, 0.2% being Syrian/lebanese and the final 9% stated that they belong to another group of ethnicity not stated. It was also seen in Table 2, that the responders were mainly from an Urban area within Trinidad with a percentage of 58.9%, whereas the minority was from a Rural area, being 41.1%. Based on the total amount of the students that participated, the highest percentage came from Form 3 students, 27.1%, with the second highest from form 2 students, 21.8%. The lowest percentage came from that of form 1's, with 5.3%.

5.12 PATTERN OF OCULAR COMPLAINTS

In this study, we listed 5 ocular complaints to be chosen from when answering the questionnaire. These ocular complaints: were headaches, dry/gritty eyes, itchy eyes, blurry vision and double vision. The relationship between the gender of the participant and the ocular complaint stated, were assessed and compared. Due to the comparison between genders, the total participants accounted for was 426, rather than the 435 students that participated, as 9 participants preferred not to specify their gender.

From the results, **(Tables 3-7)** it was noted that the ocular complaint which most participants stated they had experienced, were headaches 66% responders, followed by dry/gritty eyes 44.4% responders, blurry vision 44.1%, itchy eyes 37.1% and finally double vision 19.7%. These findings are like that of a previous study done by Pulla A et al., to assess the prevalence and associated factors of computer vision syndrome among engineering students of Hyderabad, Telangana. This study also had headaches as its most common ocular complaint among its participants.[52] Likewise, a study done by Khan A et al, to investigate Digital eye strain among undergraduate medical students in a tertiary eye care hospital of South India, also had similar findings, where headaches was the most common ocular symptom experienced, followed by dry eyes. [53]. Another study that had similar findings was, a study done by Agbonlahor O., to investigate the presence of CVS among working class adults in Nigeria. This study showed that the most stated ocular complaint was headaches, followed by dry eyes and the least common was double vision, similar to the findings of our study.[54] Although the demographics of both studies are not the same, it does confirm that these are common patterns of ocular complaints amongst computer users. From another study that investigated the Prevalence of Digital Eye Strain, it was seen that headaches were not amongst the most common complaints. The results showed that Tired Eyes was the most common with 39.8% responders stating they experienced it, followed by Dry eyes, 31.5%, Eyestrain 30.6%, Eye discomfort 30.8% and burning eyes 27.5%. Headaches were reported by 22.3% of the responders in that study, which is not very common as compared to the other studies previously discussed.[55]

In this study, there were 281 participants that answered yes for experiencing headaches, the majority, 163, 74.1 %, were males, whereas 118, 57.3% were females. Therefore, it is seen that male secondary school students experienced headaches more frequently that the females, during use of their digital device. **Table 3.** This finding agrees with results of a study done, by Yi-Ting Wei D. et al, which investigates cluster headaches. The results from this study showed that males were more affected by cluster headaches than females.[56] Although in our study there were no specifications that the headaches experienced were cluster headaches, it is known that eye

strain can induce various types of headaches such as migraines, cluster headaches and tension headaches. These headaches can arise from the strain of the orbicularis oculi muscle, contracting irregularly whilst being used for long periods of time especially when using a digital device without taking breaks.[56][57][58]

Dry/gritty eyes were experienced by 189 participants. From the total responders, 50% of males experienced dry/gritty eyes whilst 38.3% of females also experienced dry or gritty eyes. These results did not coincide with findings from another study by Ayaki M. et al, where the gender differences in adolescent dye eyes were investigated. From that study, it was noted that the presence and severity of Dry Eyes were more in the adolescent girls 34.9% as compared to adolescent boys, 23.8%.[59] In our study, most of the participants, that is, 237 students stated that they did not experience this ocular complaint with use of their device. Therefore 55.63% of the participants did not have dry eyes. These findings were similar to a study done by Kolla A. et al, to investigate the prevalence of dry eye in college students at Uparwara community in Raipur, as it was seen that of the total participants, 116 (48.3%) participants reported dry eye symptoms and 124 (51.6%) of participants was normal. Also, of those 116 participants that stated they experienced dry eyes, the majority came from males being 76%, whereas 24% were females. [60]. Another study which has similar findings, was that done by Ahujal S. et al, where the factors and prevalence of digital eye strain among screen users was observed. It was seen from the results of that study that the presence of dry eye complaints was more in males as compared to females, with a 84.21% presence in males and a 71.73% presence in the females.[61] This correlation between gender and dry eyes as shown in the last two mentioned studies, is also seen in the results of our study. **Table 4.**

Blurry vision was the third most common ocular complaint amongst the participants, where 188 students stated they experienced it with use of their digital device, that is 44.13% of the respondents. Of the 188 students that answered yes, the majority was again males, with an amount of 119, whereas only 69 females answered yes. In

general, most of the participants, that is 238 students, which is 55.87% of participants, stated that they did not experience blurry vision whilst using their device. **Table 6** Blurring of vision as well as double vision with use of digital devices can be explained by either dry eye symptoms, eye fatigue or the inability of the eye to relax accommodation leading to the difficulty in focusing. [62]

Itchy eyes was the forth common ocular complaint amongst the students who participated. From the total amount of students who participated, 158 stated they experienced itchy eyes, 95 of which were males, whereas 63 were females. Therefore 43.2% of the males had itchy eyes whereas 30.6% of the females had itchy eyes, therefore the majority of males and females both stated that they did not have itchy eyes during use of their digital device. **Table 5**

The least common complaint amongst the students was double vision. Most participants, 342, stated that they did not experience double vision whilst using their digital device, whereas 84 of them stated that they did experience double vision. From the total amount of students that answered yes, the greater number came from males, 53, and therefore only 31 females said yes. Of the females, only 15% stated they experienced double vision, and only 24.1% of males experienced it as well. **Table 7**

From the analysis of data of all the tables, (**Tables 3-7**), it can be seen that the majority of participants did not experience ocular complaints with the use of their digital devices, whereas those that did experience ocular complaints, were mostly male students. These findings opposed those of various studies, one of which was a study done in Saudi Arabia, where the researchers concluded that the presence of CVS was associated more with the female gender than the male gender [35]. Likewise, another study that opposed these findings of our research, was that done by Agbonlahor O, where the CVS was also present more in females 74%, than males 56%. [54]

The severity of these ocular complaints were also stated by the responders as seen in **Figures 2-6.** The ocular complaints were graded on a scale of 1-10, with 1 being the least severe and 10 being the most severe. The most severe ocular complaint was headaches, were 36 participants indicated that the severity was a grade 10. However, the majority of participants who graded these headaches, 60 students, stated that they were grade 1, being least severe. **Figure 2.** For Dry/Gritty eyes, the majority of the participants who experienced dry eyes, 94 students, ranked its severity as 1 out of 10, being the least severe, whereas the least number of participants, that is 17 students, stated it was a 10 out of 10, being most severe. **Figure 3.** The severity of itchy eyes was mainly ranked to be 1 out of 10, being least severe by 110 participants, whereas the number that stated it was 10 out of 10 severity, being most severe was 14 students. **Figure 4.** Blurry vision was also ranked least severe, being 1 out of 10, by the majority of students who experienced this ocular complaint, that being 106 students, whereas the minority of students, 18 students, stated they experienced a 10 out of 10 severity of blurry vision. **Figure 5.** Double vision was the ocular complaint that most students ranked to be the least severe, where 313 students ranked it 1 out of 10, and only 4 students ranked it 10 out of 10. **Figure 6.**

In general, based on assessment of **Tables 3-7** and **Figures 3-6**, there was a larger amount of students who had no presence of ocular complaints, and those that did, the majority had symptoms that were not very severe. However, although this may be the findings, there was still a presence of ocular complaints amongst the students during online learning. It can be seen from **Figure 7**, that there was indeed an increase in the presence of ocular complaints before remote learning and after transitioning to remote learning, due to COVID-19. It can be seen that headaches were the most developed ocular symptom experienced, as 193 students stated they experienced headaches before transition to online learning, whereas 285 students stated they experienced headaches after transition to online learning, with use of their digital device. Likewise, the presence of Dry/Gritty eyes increased from 152 students to 193 students, presence of blurry vision increased from 150 students to 192 students, Itchy eyes increased from 126 students to 160 students and the least developed ocular complaint was double vision,

which increased from 69 students to 85 students experiencing it. Therefore, online learning did increase the prevalence of ocular complaints among students.

5.13 FACTORS CONTRIBUTING TO OCULAR COMPLAINTS

There are various factors which can contribute to ocular complaints, two of those analysed are duration of time spent on digital device and the posture of students whilst using the device.

From **Table 8**, it is seen that the majority of students who stated they experienced headaches, 170 students, used their devices for 4-6 hours a day, whilst the second highest amount, 79 students, used their devices for more than 6 hours. Students who used their device for less than an hour, had the lowest number of participants that stated they experienced headaches, that being 8 students. This can therefore show that an increase in the hours spent on the digital device can contribute to the presence of headaches. This finding confirms that of other studies which shows that screen time of more than 4 hours a day does lead to a higher prevalence of headaches among persons as compared to those who spend less than 4 hours a day. [63][64][65]

The results of **Table 9** showed that most students did not experience dry/gritty eyes, with 242 students stating they did not, whereas 193 students stated they did. However, of the 110 students who spent more than 6 hours on their device, the majority of that being 60 students, did indeed state that they experienced dry eyes, whereas the other 50 stated they did not. This can therefore show that spending a prolonged time, that is more than 6 hours on a device, can in fact induce dry eyes in the user. This is seen in a study done by Al Tawil L. et al, which investigated prevalence of self-reported CVS symptoms and factors among university students of Saudi Arabia, where the second most common ocular complaint was dryness of the eyes being 51.5% of responders, and it was also noted as the most severe symptom experienced.[66]. In another study not done on students, but rather adult Japanese officer workers, it is seen that the time spent on their device that amounted to more that 5

hours did impact the presence of the Dry eye symptoms, therefore leading to screen time being labelled as a risk factor for CVS. [66]

The presence of dry/gritty eyes were highest among students who spent 4-6 hours on their device, with 115 stating its presence. However, the amount of students who spent this same amount of time on their device without the presence of dry eyes, did amount to more than those that presented with it, being 142 students. This finding does not follow those of studies previously stated.

The presence of itchy eyes showed no correlation to the number of hours spent on a digital device. Those who stated they experienced itchy eyes were 160 students, which was less than the amount that stated they did not experience it, being 275 students. However, of those students who stated that they experienced this discomfort, the highest number came from those who spent 4-6 hours on their device, and the second highest came from those who stated they spent more than 6 hours on their device, being 95 and 49 students, respectively. **Table 10**

Similarly, the presence of blurry vision nor double vision showed any correlation with the duration hours spent on the digital device. The majority of participants stated that they did not experience these ocular complaints with use of their digital device. From **Table 11** it can be seen that 243 participants stated that there was not a presence of blurry vision, whereas 192 students stated there was a presence of blurry vision. Of those students that stated they did indeed experience blurry vision with use of their device, the majority came from those that spent 4-6 hours on the device, that being 111 participants, whereas the second highest came from those that spent more than 6 hours on their device, being 52 participants.

Likewise in **Table 12,** of the 435 participants, the majority stated that they did not experience double vision, that being 350 students, whereas 85 stated that they did indeed experience double vision. Of those 85 students that stated they experienced this ocular complaint, the majority came from those that spent 4-6 hours on their device, whereas the second highest came from those that spent more than 6 hours, being 42 participants and 31 participants respectively.

Overall, the results of these tables showed that although more students did not experience ocular complaints as compared to those who did. The numbers of those who did experience ocular complaints, were higher in the groups that used their devices for more than 4 hours. Based on **Figure 9,** it is also seen that there was an increase in time spent on digital device during the COVID-19 pandemic, whereas prior to this, more students spent less time on their devices. Before COVID-19, the majority of students, 146 students spent 2-4 hours on their device, with the second highest, 85 students, spending 1-2 hours on their device. However, during COVID-19, the majority of students now spent 4-6 hours on their device, 257 students, with the second highest amount,110 students, spending more than 6 hours on their device. Therefore, the switch to online classes and the presence of the COVID-19 pandemic did lead to an increase in the amount of time spent on digital devices. This finding is confirmed in another study where 93.6% of the responders of this study stated there was an increase in usage of their digital devices after lockdown. It was seen that the majority of the responders, 32.4% spent 9-11hours on their device, 26.5% spent 6-8hours on their device and 16.5% spent 3-5 hours on their device.[63]

Based on **Figure 8,** the type of digital device that was most used for online learning was a laptop/MacBook, 55%, followed by a phone, 28%, then tablet/iPad 10% and least used was a desktop, 7%. In one study conducted to investigate digital eye strain on adolescents, one factor focused on was the type of digital device used. It can be seen from that study that 58.3% students used a smartphone, 37.3% used a tablet, 35.8% used a laptop, 23.8% a desktop computer and 9% used an eBook reader [42]. This study also stated that ideal distance for usage of a device is between 50cm-70cm away from the person's eyes, however because smaller devices such as smartphones are held at a closer distance to the eyes, usually 20-30cm, it can lead to a prevalence of eye strain and ocular discomfort.[42] The correlation of viewing distance and eyestrain was investigated in another study, where it was found that symptoms of blur, tired eyes and discomfort in eyes increased after use of the smartphone allowing researchers to conclude that there is a significant correlation between the viewing distance and eyestrain symptom as closer distances cause greater effect of symptoms.[36] This conclusion was also confirmed one of the findings in another study, where it was found that the viewing distance is directly related

to ocular complaints, since the increased distance when using devices lead to a decrease in 36% in the ocular complaints . [34]

Tables 13 - 17 show the relationship between ocular complaints and the preferred posture used by the students while using their digital device for online learning. Of the 285 students that stated they experienced headaches. 203 came from those students that preferred sitting during their online classes. While the second highest came from those that said they preferred standing, Being 42 participants. From the 193 students that stated they had presented with dry or gritty eyes. The majority came from those that preferred sitting while using their digital device, being 128 participants, with the second highest being most common in those that preferred standing, being 57 participants. From the 160 students that stated, they had the presence of Itchy eyes. The majority came from those students that stated they preferred sitting whilst using their digital device, being 110 participants, and the second highest being those that preferred standing, 28 participants. This pattern continued to be quite noticeable, as those students that stated they had blurry vision, the majority came from those who stated they preferred sitting while using their digital device, while the second highest came from those who stated they preferred standing or another posture. Lastly although most students stated that they did not have the presence of double vision. Those 85 participants that stated they did indeed have double vision with use of their device, the majority came from those that preferred sitting being 55 participants, with the second highest being those who preferred standing, being 17 participants.

From these results the postures which presented with the higher numbers of ocular complaints, were sitting and standing. This can therefore bring the assumption that the students who sat or stood up to use their digital device during online learning, possibly held an improper posture for an extending period contributing to the ocular complaint. There were more participants that stated they did not experience ocular complaints with use of their digital devices, compared to those who stated that they did experience ocular complaints or discomfort with use of their device. In a similar study done, most students preferred to sit while reading, that being 77.3%, whilst only 21.4% preferred to lay down, whilst 1.4% chose to either sit or lay on a bed while reading.[42] Although

this study found no correlations between eyestrain and posture, it was stated that it is known through attributions from other authors, that an improper posture can lead to an increase in eye strain and position such as hunching the back can lead to neck and back pains.[42] In another study done, where ergonomic practices and CVS were studied, it was found that the symptoms of Computer Vision Syndrome occurred less by holding the device just below eye level and improving ergonomic practices could also reduce the symptoms. [44]

In this research study most of the responders came from student of Form 3 classes with 118 responders. Form 2 had 95 responders, Form 4 had 75 responders, Form 6 had 71 responders, Form 5 had 53 and lastly, Form 1 had 23 responders.

The larger number of students who spent 4-6 hours on their devices were from Form 3 students, with a number of 71 students. Students that spend more than 6 hours on their devices were mainly Form 5 students, with a number of 25 respondents, whereas the second highest came from form 3 and Form 5 students, being 24 students each. From the total number participants that being 435 students, the majority of them 257 students spent 4-6 hours on their device, where the second highest number of responders, 104 students, spent more than 6 hours on their devices. **Table 18.** This therefore shows that the majority of secondary school students spend over 4 hours on their digital devices, making them at risk of digital eye strain and likewise computer vision syndrome.[66]

5.14 RESPONSIVENESS TO OCULAR COMPLAINTS

The results for the responses regarding responsiveness to ocular complaint starts on table 18. The options which were given to the students with respect to how they relieve their ocular symptoms were: take breaks, glasses, visit the doctor, medication and other. The symptom to be relieved in this table was headaches. It can be seen in the table that most of the students who experienced headaches choose to do nothing about it. Out of the 285

students who said they had experienced headaches, 175 of those students decided to do nothing to resolve their discomfort. The other 110 students relieved their headaches by other methods.

Continuing on in table 19 the students who experienced the presence of dry/gritty eyes also did nothing to relieve their discomfort. Out of the 193 students who experienced dry/gritty eyes, 123 of the students went for the option of not doing anything. The other 70 students resolved their dry/gritty eyes using other methods

In table 20 a similar pattern is being seen with 101 students doing nothing about experiencing itchy eyes out of the 160 students who had this ocular problem. The remaining 59 students choose to alleviate their itchy eyes by other means.

With respect to tables 18,19,20 and 21, by now it can be seen that most students went with the option of doing nothing to alleviate their ocular discomfort. In table 24 out of the 192 students who found blurry vision to be an issue 119 students did nothing to fix this issue. The remaining 73 students solved their blurry vision by other methods.

In the last table, table 22, out of the 85 students that experienced double vision 48 students did nothing to resolve the problem. The other 37 students relieved their double vision by other methods.

While the most common response for dealing with ocular complaints seemed to be doing nothing. It can be said that the second most common response for dealing with the ocular symptoms is taking breaks. A possible reason for this is because the students are so focused on the projects, assignments etc. that they need to complete that they choose to do nothing. However, the second most common response to the ocular problems was to take breaks which is an effective solution to the ocular complaints being experienced but while they are taking breaks the 20-20-20 can be applied to further help with the ocular discomfort. It also happens to be a cost-effective solution as it does not require the student to visit an eye care professional. However, according to a study done among medical students in a university in Karachi, Pakistan, the symptoms of Computer Vision Syndrome

improved after taking more breaks but there was no significant association between the number of breaks and relief of symptoms. The study added that there is also research which suggests that taking breaks does not help with the symptoms of Computer Vision Syndrome while there is contrasting research which suggests the opposite; taking breaks lessens the symptoms of Computer Vision Syndrome. In a study done evaluating the prevalence and risk factors of CVS among computer office workers in Sri Lanka the researchers stated that taking breaks was not significantly associated with the prevalence of CVS [38] [39]. While there seems to be no conclusive research which states that taking breaks alleviates the symptoms of CVS and its related ocular problems, it was the second most common response to ocular complaints in our study. In a report done by the American Optometric Association (AOA) it was estimated that about 14% of patients get their eyes tested because they suffer from computer vision syndrome without being aware of it [38]. It was found that the number of students that visited the doctor for each ocular compliant was: 6 students visited the doctor because of headaches out of 435 (1.38%), 5 students visited the doctor because of dry/gritty eyes out of 435 (1.15%), 4 students visited the doctor due to itchy eyes out of 435 (0.92%), 6 students visited the doctor because of blurry vision out of 435 (1.38%) and only 2 students visited the doctor because of double vision out of 435 (0.46%). From these results it can be seen that very few student's response to ocular complaints was to visit the doctor to relieve the issues they experienced.

5.15 IMPACTS OF OCULAR COMPLAINTS ON THE QUALITY OF LIFE

Moving on to discussing the impact that using digital devices have on the quality of life. From the results shown on table 23 it can be seen that the majority of students (162 students) experienced no difference in the quality of life. However, 142 students said that their quality of life was severely affected this group of students also made up the second largest majority. 80 student said there was a moderate effect of the quality of life and 52 students there was barely any effect. These results are quite troubling as the students who said they have been

severely affected by the use of digital devices can also have ocular discomfort which can possibly reduce the quality of their school work and their ability to function and focus on class while using digital devices, as well having health related issues due to excessive digital device use.

While the studies and research which document the quality of life when associated with digital device use is limited, there are some studies which can still be of use. In a study done assessing how blue light emission from digital devices affect sleep it was found that 286 (97.3%) of students used a smart device that emits blue light, at bedtime before sleep. Of those students, 101 (35.3%) stated that they had poor sleep quality. The perception that their sleep was disturbed by night usage of their device was stated by 188 students (65.7%). The mean sleep duration of students obtained during this study was 6.3 hours, where 119 students (63.3%) admitted to fatigue on waking, 76 students (40.4%) presented with poor sleep quality. There is an assumption that impaired sleep can lead to many health-related concerns such as mood disorders, obesity or increased accidents [46]. What this research is suggesting is that blue light emission from smart devices can lead to reduction in sleep quality which can in turn have negative effects on the students such as the ones previously stated.

From the research talked about previously it was shown that digital devices can affect the quality of sleep but another effect digital devices can have are musculoskeletal disorders. In a study done in Taiwan, it was found that the parts of the body which were stated to have experienced the most pain commonly were; the neck, shoulders, upper back and lower back, due to poor body structures which thereby affect their musculoskeletal system. From the analysis, it was seen that almost half the students experienced neck and shoulder discomfort [48].

From these studies it can be seen that excessive digital device use can have a serious impact on the quality of life of students causing problems such as poor quality sleep, musculoskeletal disorders and can cause potential problems such as mood disorders, obesity and increased accidents.

5.2 CONCLUSION

The transition from physical classrooms to remote learn due to the COVID-19 pandemic had various impacts on the secondary school students of Trinidad. The hours of use of student's digital devices increased due to not only the transition of learning to online, but also due to the inability of students to interact and socialize with other children, thereby leading to them depending on their devices for entertainment, socialising and education as well. Despite the majority of responders not having severe ocular complaints, there was indeed an increase in the presence of ocular complaints from before remote learning as compared to during remote learning. This can be due to the increased time spent on their devices and the unawareness of ways in which to preserve their eye health whilst heavy usage of digital devices, as well as the proper posture and distance to be at when using their devices. Headaches was a common ocular complaint amongst students as well as dry eyes. While the secondary school students stated that they experienced ocular complaints such as headaches, dry/gritty eyes etc. a large majority of the students choose to do nothing to resolve their discomfort and only a very small amount of students decided to take breaks or visit a doctor to try and resolve their problems. The reason for this could be a lack of awareness due to the students not knowing that help is available to them to try and solve these problems or simply due to not wanting to ask for help. While there was a large majority of students (162 students) that said that they experienced no difference in the quality of life, the second largest majority of students (142 students) said that their quality of life was severely affected and since there was a large amount of students who also said that they did nothing to solve their discomfort/problems this could have serious implications later on in life if they continue do nothing about these issues. Some of the health related risks that can arise are poor quality sleep which can lead to mood disorders, obesity, increased vehicular accidents and musculoskeletal disorders.

5.3 RECOMMENDATIONS

1. This study should be done at the end of March of 2022 at a larger scale, reaching more students to truly investigate how the transition of online school has affected students' eyes and results be compared to this study.
2. Students should be advised and educated about Digital Eye Strain and Computer Vision Syndrome, so as to understand its implications.
3. Students should be advised about various ways to preserve their eye health whilst using their digital devices, such as the 20/20 rule, where they can take a break at every 20-minute interval to look at an object in the distance for 20 seconds.
4. Teachers should assess their students every 6 months to ensure there have been no drastic changes to their ocular health due to remote learning
5. Optometrists should be invited to schools to do annual eye exams on students to monitor their ocular changes as well.

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APPENDICES

Questionnaire

Ocular Health with Digital Device Usage

This survey aims to investigate the pattern and responsiveness to ocular complaints among students learning remotely during COVID19 through a quantitative study.

Please note your name will not be used for analysis of results.

* Required

1. How old are you? *

Mark only one oval.

- ◯ 12-13
- ◯ 14-15
- ◯ 16-17
- ◯ 18-19

2. What is your gender? *

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say

3. Are you a citizen of Trinidad? *

Mark only one oval.

- Yes
- No

4. What is your ethnicity? *

Mark only one oval.

- Afro-Trinidadian
- Indo-Trinidad
- Chinese
- Syrian/Lebanese
- Mixed
- Other

5. What is the nature of community in which you live? *

Mark only one oval.

- Rural area
- Urban area

6. How long have you been living in Trinidad? *

Mark only one oval.

- Less than 1 year
- 1-2 years
- 3-4 years
- 5 years & above

7. What form are you in? *

Mark only one oval.

- ◯ Form 1
- ◯ Form 2
- ◯ Form 3
- ◯ Form 4
- ◯ Form 5
- ◯ Form 6

8. Did you use a digital device for schooling during COVID 19 Pandemic? *

Mark only one oval.

- ◯ Yes
- ◯ No

9. If yes, what Digital Device was used ? *

Mark only one oval.

- ◯ Phone
- ◯ Tablet/iPad
- ◯ Laptop/Macbook
- ◯ Desktop
- ◯ Television
- ◯ Other: _____

10. Before the closure of school due to COVID-19, How many hours a day on average, did you spend on your digital device daily? *

Mark only one oval.

- Less than an hour
- 1-2 hours
- 2-4 hours
- 4-6 hours
- More than 6 hoursOther:
- _____

11. How many hours a day on average, do you spend on your digital device daily as online teaching is taking place? *

Mark only one oval.

- Less than an hour
- 1-2 hours
- 2-4 hours
- 4-6 hours
- Other: _____

12. Do you wear glasses or contact lens? *

Mark only one oval.

- Glasses
- Contact Lenses
- Both contact lenses and spectaclesNeither
- glasses nor contact lenses

13. If you do wear glasses or contact lens, do you wear themwhile using your digital device? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

14. What is your preferred position while using your digital device for schooling during COVID 19? *

Check all that apply.

- ☐ Sitting
- ☐ Standing
- ☐ Laying down
- ☐ Other

15. How long do you spend in that preferred position while using your digital device? *

Mark only one oval.

- ◯ Less than 1 hour1
- ◯ - 2 hours
- ◯ 2 - 4 hours
- ◯ 4 - 6 hours
- ◯ More than 6 hours

16. Do you have problems seeing at near or distance?

Mark only one oval.

- ◯ Near
- ◯ Distance
- ◯ I see well both near and distance

17. Do you have any eye turns? (Eyes turned inward or outward and commonly known as a "lazy eye" or "kokey eye")

Mark only one oval.

- ◯ Inward
- ◯ Outward
- ◯ No

18. Did you experience headaches with use of your device before COVID-19? *

Mark only one oval.

- ◯ Yes
- ◯ No

19. If you answered yes to the above, On a scale of 1-10 how bad were your headaches?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very much

20. Did you experience dry/gritty eyes (feeling as though something is in your eyes) with use of your device before COVID-19? *

Mark only one oval.

- Yes
- No

21. If you answered yes to the above, On a scale of 1-10 how bad were your dry/gritty eyes?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very											Very much

22. Did you experience itchy eyes with use of your device before COVID-19? *

Mark only one oval.

- Yes
- No

23. If you answered yes to the above, On a scale of 1-10 how bad were your itchy eyes?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very											Very much

24. Did you experience blurry vision with use of your device before COVID-19? *

Mark only one oval.

- Yes
- No

25. If you answered yes to the above, On a scale of 1-10 how bad was your blurry vision?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very											Very much

26. Did you experience double vision with use of your device before COVID-19? *

Mark only one oval.

- Yes
- No

27. If you answered yes to the above, On a scale of 1-10 how bad was your double vision?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very											Very much

28. Do you currently experience headaches with the use of your digital device? *

Mark only one oval.

- Yes
- No

29. If you answered yes to the above, On a scale of 1-10 how bad are your headaches?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very											Very much

30. Do you currently experience dry/gritty eyes (feeling as though something is in your eyes) with use of your digital device ? *

Mark only one oval.

- Yes
- No

31. Do you currently experience itchy with the use of your digital device? *

Mark only one oval.

- Yes
- No

32. If you answered yes to the above, On a scale of 1-10 how bad are your dry/gritty eyes?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very much

33. If you answered yes to the above, On a scale of 1-10 how bad are your itchy eyes?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very much

34. Do you currently experience blurry vision with the use of your digital device? *

Mark only one oval.

- ◯ Yes
- ◯ No

35. If you answered yes to the above, On a scale of 1-10 how bad is your blurry vision?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very much

36. Do you currently experience double vision with the use of your digital device? *

Mark only one oval.

- ◯ Yes
- ◯ No

37. If you answered yes to the above, On a scale of 1-10 how bad is your double vision?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not very	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very much

38. Did you try to resolve any of the symptoms above on your own? *

Mark only one oval.

- ◯ Yes
- ◯ No

39. If yes, What did you do to resolve the symptoms experienced?

40. When was your last eye exam? *

Mark only one oval.

- ◯ Within the last 6 months
- ◯ Within the last year
- ◯ More than a year ago
- ◯ More than 2 years ago
- ◯ Never had an eye exam
- ◯ Other: _____

41. If you got an eye exam done within the last year, was it because of some of the complaints mentioned above? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

42. If yes, What is the nature of the eye clinic attended?

Mark only one oval.

- ◯ Government
- ◯ Private

43. How would you say the above treatment has helped you?

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not helpful	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very helpful

44. What was the nature of the treatment?

Mark only one oval.

- ◯ Glasses
- ◯ Eye drops
- ◯ Vision Therapy
- ◯ Medication
- ◯ Other: _____

45. How would you say online learning has affected your eye health? *

_____

_____

_____

_____

_____

46. How would you say online learning has affected your vision? *

_____

_____

_____

_____

_____

47. Has online learning affected your quality of life/dailyroutine/activities? *