Asthenopia among undergraduate students of the University of the West Indies, St Augustine Campus, Trinidad and Tobago.

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ABSTRACT

Background

Asthenopia refers to discomfort experienced while performing near tasks. It encompasses symptoms such as headaches, eye strain, ocular fatigue, diplopia and dry eyes. Asthenopia can been categorized as accommodative, muscular, nervous and photogenous according to the respective etiologies. Poor ergonomics and visual hygiene have been found to increase symptoms.

Objective

To determine the prevalence and associated factors of asthenopia in undergraduate students of the St. Augustine Campus of the University of the West Indies, St. Augustine, Trinidad and Tobago.

Method

This study was a prospective, descriptive, cross sectional study of the prevalence of asthenopia and asthenopic symptoms in a university setting, targeting persons aged 18 to 30 during the period of January 2020 to April 2020. Stratified convenience sampling methods were used to obtain data representative of the overall population of the University of the West Indies, St. Augustine Campus. An online self-administered questionnaire was circulated, consisting of approximately 15 questions. Persons were considered to have experienced asthenopia if they reported experiencing four or more mild symptoms, two or more moderate symptoms or one severe symptom with at least one other symptom.

Results

Of the 129 samples collected, 102 fit the inclusion criteria. The prevalence of asthenopia in undergraduate students was found to be 85.3% (87). It was observed that 98.3% (57) of female population experienced asthenopia compared to 68.2% (30) in the male population. The most common symptoms recorded were eye fatigue (64.7%) and headaches during near work (57.8%) and watery eyes (56.9%).

Conclusion

The prevalence of asthenopia in undergraduate university students was found to be high. It is necessary to treat this condition in order to decrease the severity of the symptoms.

CHAPTER ONE: INTRODUCTION

In 2018, it was found that the average person spends 11 hours a day looking at a screen.[1] However, with prolonged screen time, the eyes are placed under significant strain as they are forced to maintain the conditions required for near point tasks for anywhere between a few minutes to several hours at a time. The muscles outside of the globe responsible for the movements of the eyes as well as the muscles inside of the eye which are responsible for accommodation and refocusing near targets can become fatigued. [2]

The clinical term "Asthenopia" refers to discomfort associated with prolonged near-point activities. Asthenopia which affects those reliant on electronic devices is frequently referred to as 'Computer Vision Syndrome (CVS)'.[3] Furthermore, with the advent of computers and mobile devices, students have become more dependent on the use of these devices which has led to an increased prevalence of asthenopia.[4] It is possible that students who spend several hours reading without frequent breaks are at greater risk for experiencing asthenopic symptoms than the general public. The symptoms associated with asthenopia could possibly affect students' academic performance, which in turn may impact a student's psychological wellbeing.

This study therefore intends to determine the prevalence of asthenopia with focus on the undergraduate student population of the University of the West Indies, St. Augustine Campus, Trinidad and Tobago. This chapter gives further insight into the topic of asthenopia and the rationale of the study including the specific objectives and the research questions which this study aims to answer. This chapter also outlines the limitations which were experienced as well as defines commonly used terms which were used throughout this study.

1.1 Background of Study:

Asthenopia has been categorised into 4 different categories based on the etiology or cause:[5]

- Accommodative Asthenopia – which encompasses asthenopic symptoms which are caused by strain of the ciliary muscle responsible for the accommodation of the lens, this is inclusive of accommodative anomalies as well as from uncorrected refractive errors.
- Photogenous Asthenopia – which is due to the improper or excessive lighting conditions in a workspace.
- Muscular Asthenopia – which refers to asthenopia caused by an imbalance of the extraocular muscles which control the movements of the eyes
- Nervous Asthenopia – which can be due to functional or organic nervous disease.

There are also several factors that increase the risk of developing asthenopia. Visual stress, long periods of time performing near point tasks without taking frequent breaks, environmental factors such as improper or excessive lighting, poor ergonomic arrangement of the workspace, noise, unsuitable indoor temperature and humidity.[6] Psychological factors such as daily stress or job stress, poor mental state and social identity and exhaustion or burnout can also increase the risk of developing asthenopia.[7] The person's health status, dietary and lifestyle choices all affect the development of asthenopic symptoms. The presence of ocular or systemic disease, low intake of green leafy vegetables, poor sleep quality and insufficient duration of sleep have all been identified as risk factors for the development of asthenopia.[8]

Some asthenopic symptoms which are frequently experienced are headaches, eye strain, pains inside the eye, double vision, blurry vision, increased sensitivity to light and even itching, burning and watery eyes. These symptoms make it increasingly difficult for the individual to perform near tasks without discomfort and may result in a reduced capacity to perform near tasks and a lack of motivation to perform these tasks. Asthenopia is diagnosed by taking a thorough history and the presence of these asthenopic symptoms in the absence of serious eye disease. [3]

Testing, therefore, is geared toward determining the causative factors rather than making a diagnosis. Testing begins with a refraction to determine the current prescription for correcting

the persons refractive error, checking for heterophoria or heterotropia using Hirschberg method and cover testing, negative and positive relative accommodation testing and accommodative convergence to accommodation (AC/A) ratio, accommodative facility with flipper lenses and near point of convergence with a RAF rule. These tests will determine whether the cause is refractive, accommodative, or muscular in nature which is the first step to managing asthenopia. [3]

Using a combination of tactics including increasing ergonomic efficiency, maintaining good body posture and visual hygiene asthenopia can be prevented. Some efforts which can reduce asthenopia are keeping reading material at Harmon distance, having reading material angled to reduce bending of the head and neck, taking frequent breaks to move around and utilizing the 20-20-20 rule which suggests that after 20 minutes of screen time you look at an object at least 20 feet away for 20 seconds. Asthenopia can lower an individual's performance especially those who are required to have several consecutive hours of screen time however utilizing these very simple and effective strategies can greatly increase the person's comfort and productivity while combatting asthenopia and the discomfort which it brings.[9]

1.2 Statement of The Problem

Globally, it is estimated that 60 million individuals experience asthenopic symptoms due to computer usage, thus decreasing the computer user's productivity and quality of life.[10] It is possible that asthenopia can have a grave negative affect on the academic performance of a student.[11] While studies have been conducted at other global locations investigating the prevalence and factors of asthenopia, there are currently no studies which were conducted in Trinidad. Therefore, there is a paucity of literature based on studies of asthenopia, specifically in university students in Trinidad. This study is therefore geared to determine the prevalence of this problem amongst undergraduate students of the University of the West Indies, Trinidad and Tobago.

1.3 Aim of Study

This study intends to determine the prevalence of asthenopia among the undergraduate student community of the University of the West Indies, St. Augustine Campus, Trinidad and Tobago.

1.4 Specific Objectives of Study

- To assess the prevalence of asthenopia among undergraduates of UWI St Augustine campus.
- To determine the most prevalent symptoms of asthenopia.
- To evaluate the associated factors of asthenopia.
- To identify the major causes of asthenopia.
- To assess the distribution of asthenopia with respect to demographics.

1.5 Research Questions

1. What is the prevalence of asthenopia amongst undergraduate university students?
2. What are the most prevalent symptoms of asthenopia in undergraduate university students?
3. What are the associated factors of asthenopia in undergraduate university students?
4. What are the major causes of asthenopia in undergraduate university students?
5. What is the distribution of asthenopia amongst undergraduate university students according to demographics?

1.6 Significance of Study

- Findings from this study will assist in expanding the awareness of asthenopia as well as its related symptoms and associated factors to both students as well as the general population.
- In addition, this study will add to the reservoir of statistical data for the territories of Trinidad and Tobago and by extension, the Caribbean.
- It will also serve as a base line for further studies.

1.7 Delimitation of Study

- This study focused specifically on the Undergraduate student population of the University of the West Indies, St Augustine.

1.8 Limitation of Study

- The quality of data gathered is limited as it relies on the participant to comprehend what is being asked and report the symptoms which they believe they experience.
- Inability to collect qualitative data since the investigators were not able to measure the severity of the asthenopia of each participant using practical tests.
- Candidates' responsiveness to questionnaires.
- Insufficient time to collect the ideal amount of responses.
- Working against the COVID-19 outbreak.

1.9 Definition of Terms

These definitions were sourced and paraphrased from Oxford's A Dictionary of Ophthalmology:[12]

20-20-20 Rule – Every 20 minutes of computer use or near work activities, stop and look at object at 20 feet or more away for 20 seconds.

AC/A Ratio – Accommodative convergence/ convergence ratio. A measure of the change in convergence for each unit change in accommodation.

Accommodation – The ability of the crystalline lens in the eye to change its thickness to allow light to be focused onto the back of the eye when looking at near or distant objects.

Accommodative Facility – How quickly the eye can focus on a near object from a distant object.

Accommodative Lag – A delay in accommodation when trying to focus on a near object.

Amplitude of Accommodation – The power of the crystalline lens when accommodating to view objects at varying distances.

Anterior – Front of.

Asthenopia – A series of symptoms primarily associated with eye strain.

Asthenopic Symptom – Symptoms of asthenopia which include headaches, eye strain, fatigue, watery eyes, dry eyes, burning eyes or blurry vision.

Astigmatism – A refractive error where neither the cornea nor crystalline lens obeys a perfectly spherical shape.

BCVA – Best Corrected Visual Acuity. The best visual result that can be obtained when correcting a patient with spectacles.

Bilateral – Both sides of an object. In the context of this study, this means both eyes.

Binocular Vision – The ability for both eyes to work together to view a single image rather than two.

Binocular Vision Anomalies/ Abnormalities – Any problem affecting the function of both eyes working together.

BMI – Body mass index. A measure of a person's height to their mass to assess their physical health.

Computer Vision Syndrome – Asthenopia brought about by excessive near work on electronic devices such as smartphones or computers.

Convergence – The ability of both eyes to move towards each other when focusing on a near object.

Convergence Insufficiency – The inability of the eyes to move towards each other when focusing on a near object.

Cornea – The transparent, dome-shaped surface of the eye situated in front of the iris.

Crystalline Lens – A structure situated behind the iris of the eye used to focus light onto the retina.

Demographics – General information about a person such as sex, age, race or address.

Dioptre – The unit of measurement when dealing with corrections for refractive errors or accommodation.

Emmetropia – Refers to an eye which has no refractive correction when looking at a distant object, meaning that distant light rays focus on the retina precisely.

Fusion – The ability of both eyes maintaining one single image, rather than seeing two.

Fusional Vergence Reserves – A measure of the maximum amount 'fusion' both eyes require to see a single image.

Harmon Distance – The distance from your fist held at your chin to your elbow on a desk.

Hyperemia – The increase in blood flow to different tissues in the body and in this case, the eye, which sometimes gives it a 'red' appearance when it occurs on the ocular surface.

Heterophoria – Also called phoria or latent squint. It is a condition where the visual axes of the eyes are aligned when both eyes are working together to maintain fusion (ability to perceive one image with both eyes), however when fusion is broken the eyes are misaligned. This can be identified by covering an eye, then moving the cover to the other eye several times while looking for movement in the previously covered eye.

Heterotropia – Also referred to as a tropia or squint. It refers to a misalignment of the eyes which is not compensated for by the fusional vergence reserves and as a result the brain may perceive 2 images as well as a visibly turned eye. This is tested for by having the subject focus

either near or in the distance and covering and uncovering the eye, then repeating on the fellow eye while looking for movement in the uncovered eye.

Hyperopia – A refractive error where near objects cannot be focused onto the retina due to a decrease in length of the eye or a flat cornea.

Iris – The coloured part of the eye.

MEM Retinoscopy – Monocular Estimated Method Retinoscopy. A test performed to assess the accommodative response of a patient.

Meta-Analysis – A scientific analysis that combine the results of multiple scientific studies.

Myopia - A refractive error where distant objects cannot be focused onto the retina due to an increase in length of the eye or a steep cornea.

Near Point of Convergence – The maximum point of convergence for the eye.

Near Point of Accommodation – The minimum distance the eye can focus.

Objective Assessment – An assessment carried out by an external party that uses data acquired from tests.

Ophthalmic Evaluation – An assessment of the ocular health of the eye using subjective and objective methods.

Orthoptic Assessment – An assessment of the muscles of the eye to ensure they function ideally.

Photophobia – Increased sensitivity to light.

Prevalence – The proportion of a population that has a specific characteristic over any period of time.

Posterior – Back or behind.

Refraction – A test carried out using a device called a retinoscope to manually or autorefractor to automatically determine the refractive error of a patient.

Refractive Error – A problem with the focusing of light onto the retina of the eye due to problems with the cornea or the crystalline lens.

Retina – The posterior structure of the eye that light focuses on.

Retinoscopy – An objective test used to measure the refractive error of a patient.

Stereopsis – The ability of the eye to view objects in 3-dimensions and perceive depth as a result of binocular vision.

Subjective Assessment – An assessment relying on an individual's opinion without any data to back up its claims.

Symptomatic – A person that reports having certain ailments from an underlying problem.

TBUT – Tear break up time. A measure of how quickly the tear layer of the eye breaks down over a period of time.

Unilateral – One side of an object. In the context of this study, it means one eye.

Vergence – The movement of the eyes in opposite directions when looking at near objects (convergence) or distant objects (divergence).

VDT – Visual display terminal. The screens on devices such as ATMs, computers, smartphones etc.

VA – Visual acuity. A measure of the eyes ability to see.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In order to establish a base understanding of the objectives of this study, literature from similar studies conducted in other countries were investigated. No such study had been done before in the country of Trinidad, where this study was carried out, nor in any Caribbean country for that matter so countries with similar ethnicities were difficult to come by. This chapter provides a review of this literature to understand and appraise the findings of studies conducted in other countries each dealing with a different demographic and target population. A total of 11 studies were analysed and arranged according to this study's objectives however information relating to each objective can generally be found in the analysis of each study.

2.2 Prevalence of Asthenopia

The aim of this project was to determine the prevalence of asthenopia mong undergraduate university students thus it was paramount that we find similar studies based on this demographic. A cross-sectional study by Hashemi et al [12] was carried out on university students in Iran to directly assess the prevalence of asthenopia and its associated factors. In this cross-sectional study ocular examinations for visual acuity, phoria and tropia, near point of convergence and amplitude of accommodation were performed on patients that met the inclusion criteria of that study. It utilised stratified random sampling by randomly choosing students from each Major of the university and aimed for a sample size of 1,595 students after taking into consideration a 10% non-response rate. The age range of these students were between 18 – 40 years and asthenopia was diagnosed based on the presence of 1 – 3 symptoms. Out of the 1,595 students, only 1,462 participated in the study where 71.2% were found to experience asthenopic symptoms. Roughly 73% of the sample population were women and it was found that asthenopia was much more prevalent in this gender group (8% more than men), as well as in those suffering from astigmatism and hyperopia. One of the assumed causes of the increased prevalence of asthenopic symptoms outlined in this study was the increased demand and exposure to computers and reading by the university students.

Another cross-sectional study done based on university students was performed by Han et al [6] in Xi'an, Shaanxi Province, China to test the prevalence of asthenopia and its associated factors over five separate universities. In this study 1,500 students, selected using the multi-stage stratified cluster sampling method, between the ages of 18 to 30 years that met the inclusion criteria were assessed using questionnaires. Of those selected, 31 did not complete their questionnaires, leaving a total of 1,469. These questionnaires not only assessed ocular health related factors of the students but also systemic health via BMI, diet and exercise as well as their environmental conditions. Male respondents amounted to 58.7% and females at 41.3%. Contrary to the previous study, it was found that there was no significant difference in the prevalence of asthenopia between males and females. Of these students it was found that 57% experienced asthenopic symptoms It was suggested that these symptoms were associated with the mental and physical health of the students, their environment and their lifestyle.

2.3 Symptoms of Asthenopia

Asthenopia can manifest itself as a plethora of symptoms and not necessarily as one or two. A cross-sectional study was performed by Musa [15] in the Alawkaf market in the city of Khartoum, Sudan where experienced computer users were assessed for computer vision syndrome (which is also a form of asthenopia). Only those with more than 4 hours of computer use a day and did not have any prior instances of computer vision syndrome or ocular disease were selected. A total of 50 subjects between the ages of 20 – 35 years were selected, and a control group of 55 other subjects with negligible computer use but similar demographics to the 50 chosen was also assessed for further comparison. Questionnaires assessing the symptoms of asthenopia were handed out to participants and complete eye examination were also performed. It was found that the most prevalent symptom was the blurring of vision which affected 62% of the computer user group compared to 12.7% of the control group. Burning eyes and headaches were also prevalent at 46% and 44% respectively of the computer user group compared to 18% and 16.3% of the control group. The least prevalent symptom was eye pain which occurred in 34% of the computer user group and 10.9% in the control group. It was suggested that the symptoms of asthenopia increased with prolonged exposure to computers.

Another cross-sectional study carried out by Al Subaie et al [14] on mobile phone users in Al-Ahsa in the Kingdom of Saudi Arabia assessed the prevalence of computer vision syndrome. Convenience sampling was done through questionnaires to random participants in a shopping mall located within the city of Al-Ahsa. The questionnaire was used to gather data on asthenopic symptoms experienced by the participants and was distributed to a total of 416 participants that were over the age of 15 and met the inclusion criteria of the study. One important consideration in this study compared to the previous study was that persons who used computers for more than 6 hours a day were excluded from the study. Of the 416 participants, 54.1% (225) were females and 45.9% (191) were males with a mean age of roughly 27 years. About 98.8% of these respondents had smartphones, with 54.1% using it for media consumption more than 3 hours a day. About 43.5% of the participants experienced asthenopic symptoms however only 23.8% consulted ophthalmologists for their complaints. The most frequent symptoms experienced by these participants were headaches at 52.4% and eye strain at 44.7%. It was found that demographics such as age, gender or occupation had no significant impact on these results. Patients with blurry vision, dry eye and ocular discomfort were also said to have a higher association with computer vision syndrome.

2.4 The Major Causes of Asthenopia

Asthenopic symptoms are commonly caused by frequent exposure to near activities. University students spend most of their time behind books and more so, computers and electronic devices. A study performed by Vaz et al [16] in an outsourcing services company in Portugal associated the increase in asthenopic symptoms with the increase in use of electronic devices. The subjects were 77 healthy adults with a median age of 34 years that met the inclusion criteria and were required to fill out two questionnaires as well as have two objective assessments performed. These assessments were to be performed a month apart from another where recommendations would be made and implemented to improve signs and symptoms of asthenopia in one of two groups after the first assessment – more on this later. Recommendations such as improving the office ergonomics, adjusting the air conditioner and visual hygiene by exercising the 20-20-20 rule were suggested. The objective assessments were carried out with a morning and evening group – the morning group having lesser exposure (<2

hours) to computers than the evening group (>2 hours). These objective assessments evaluated the dryness of the eyes, the presence of any hyperemia or lesions, accommodation insufficiency and near point of convergence. With respect to the questionnaires, the first one evaluated complaints related to ocular surface disturbances to rule out those with ocular surface disease, and the second questionnaire was used to address eye fatigue. Of the 77 individuals, 77% (59) were females and 23% (18) were males. In the first objective assessment, it was found that 44% experienced accommodative changes and 25% had changes to their TBUT. The objective measurements of the evening group were found to be statistically significant when compared to that of the morning group. After one month practicing visual hygiene and improved ergonomic efficiency, the second objective assessment was performed. There were no significant differences in objective measurements in the morning group compared to their first assessment as no recommendations were implemented with this group however, the evening group which followed the recommendations showed improvement in all objective measurements compared to their first assessment. Due to the improvements in symptoms from the first evaluation in the evening group, it was suggested that environmental factors such as lighting and air-conditioning and the prolonged use of electronic devices did have an effect on the users tendency to experience asthenopic symptoms and behavioural changes should be made to reduce this.

A systematic review and meta-analysis by Vilela et al [17] were also performed on literature about the prevalence of asthenopia and its risk factors associated with professional computer use where research on asthenopia and its relation to visual strain caused by electronic displays/ visual display terminals was gathered from various electronic databases such as MEDLINE, EMBASE, LILACS and more. The studies observed ranged from 1960 to December 2014. To eliminate risk of bias, the studies were assessed by two reviewers utilising the Downs and Black's quality score for non-randomized studies. A total of 1627 studies were identified where only 22 studies met the inclusion criteria. The 22 studies comprised a total of 36,633 individuals from twelve countries, of which a combined 40.4% showed asthenopic symptom. Hours of computer use was suggested to be the main contributor to asthenopia between most of these studies. It was mentioned that in five of the analysed studies, asthenopia was thought to affect females more however in two other studies the prevalence in females were similar to males. Refractive error was thought to be an associated factor of asthenopia in some studies, and

accommodative and convergence insufficiency were thought to be significant factors in other studies. The causes of such symptoms were thought to be prolonged use of computers of 5 or more hours a day, however environmental factors such as ergonomics, distance from computer screens and psychological state were also considered.

2.5 The Associated Factors of Asthenopia

Asthenopia can be caused or exacerbated by near work activities and use of electronic devices however there are also associated factors that may predispose persons to this problem such as refractive errors and binocular vision complications. A cross-sectional study performed by Darko-Takyi et al [18] on the prevalence of asthenopic symptoms and symptomatic accommodative disorders was performed on Junior High school children in Cape Coast Metropolis, Ghana. Multistage sampling was done where 53 students from 12 schools were selected which amounted to 636 students being sampled where 627 met the inclusion criteria. These students were within the age group of 12 – 17 and were assessed via questionnaires. Students with two or more symptoms that were considered severe or very severe were identified as symptomatic and were given a complete accommodative assessment. The accommodative assessment measured amplitude of accommodation, accommodative lag and accommodative facility. Those with spectacles had the accommodative test done with their spectacles on. Of the 627 students, 35.1% (220) students were considered symptomatic of which 37.3% (82) were male and 62.7% (138) were female. The most prevalent symptoms were headaches associated with near work at 61.8% and least was eyestrain with near work at 20%. Age did not significantly affect the prevalence of asthenopia however males were more likely to experience headaches and watery eyes related to near work activities than females. Amplitude of accommodation and lag of accommodation showed significant correlation to asthenopic symptoms. Students diagnosed with accommodative insufficiency were most susceptible to asthenopic symptoms making up 7.7% of students experiencing severe symptoms and 21.8% experiencing very severe symptoms. It was also found that there was a significant association with spectacle wearers and accommodative insufficiency. Other accommodative disorders that presented severe asthenopic symptoms were accommodative facility and accommodative fatigue.

Another study carried out by Deshmukh et al [19] dealing with non-strabismic binocular vision anomalies and asthenopia was conducted in a tertiary eye care center in North-East India, where a total of 131 patients between the ages of 10 to 40 that met the inclusion criteria were assessed using a complete ophthalmic evaluation as well as an orthoptic assessment. The ophthalmic evaluation covered visual acuity, refraction and a detailed slit lamp examination and then a follow-up examination three days after taking dilative agents if they were suspected to have asthenopic symptoms. The orthoptic assessment tested stereopsis, AC/A ratio, phoria, near point of convergence, near point of accommodation and fusional vergence. Of the 131 patients, 61.8% (81) were female and 38.2% (50) were male. Convergence insufficiency was the most common binocular vision anomaly followed by accommodative insufficiency in participants between the ages of 10 to 30 and convergence excess in participants between the ages of 31 to 40.

A study was also done by Prabhu et al [20] to assess the correlation between refractive errors and asthenopic symptoms among spectacle corrected persons. In order to assess this, 35 adult spectacle wearers that met the inclusion criteria were selected. The participants between the ages of 18 - 40 years and was made up of 57.1% (20) females and 52.9% (15) males. A basic visual assessment was carried out where retinoscopy was performed to get the participant's best corrected visual acuity as well as a verbal interview to assess if they had asthenopic symptoms. Due to the low sample size of this study, each individual eye was taken into consideration. About 27 patients experienced bilateral symptoms and 8 patients experienced unilateral symptoms, which totalled 62 eyes. Of these eyes, 10 were myopic, 26 were hyperopic and 26 were astigmatic. The major finding in this study was that near work associated headaches were observed in 62.9% (39) of eyes where out of this figure, 46.2% had uncorrected astigmatism.

2.6 Demographics of Asthenopia

Asthenopia, like many other ocular complications, may be thought to vary with demographics. A cross-sectional study done by Schellni et al [20] amongst a Brazilian population assessed the main visual symptoms associated with refractive errors and was carried out using a mobile eye unit which travelled from house to house. A random stratified sampling method was used on

a cluster of households and roughly 3,012 households containing a total of 8,010 healthy participants between the ages of 1 and 96 years that fell into the study's inclusion criteria were selected for the study. Of these participants, 7,654 were objectively assessed. Asthenopia was the most prominent ocular symptom at a prevalence of 59.6% amongst the participants. Total female participants amounted to 62.7% and males amounted to 37.3%. The frequency of asthenopia was closely distributed between both genders, as 61.8% of the female population and 55.8% of the male population experienced asthenopic symptoms. There was also a higher frequency of asthenopia amongst younger age groups with 96.1% in the 1st decade of life and 85.9% in the 2nd decade of life, with a significant decrease after the 4th decade of life as these participants complained more about poor near vision. Asthenopia was generally associated with refractive errors where 73.1% of those that suffered from myopia and 60% of those with astigmatism experienced symptoms.

Another cross-sectional study done by Vilela et al [11] assessing asthenopia in schoolchildren between the ages of 6 – 16 years was performed in two public schools in Brazil. Participants were selected based on lists provided by schools, where chosen participants that met the inclusion criteria were contacted via telephone or personal visits to confirm their attendance to the selected schools. A questionnaire based on socioeconomics and culture was answered by the parents of the selected students and another questionnaire was given to the students based on asthenopia. An objective assessment was carried out to test the visual function of children using VAs, refraction, cover test, stereopsis tests, phoria tests, AC/A ratio and near point of convergence. A sample size of 970 students were chosen however only 964 children were assessed where the prevalence of asthenopia was found to be 24.7%. There was an association with asthenopic symptoms in children that were older, with 51% of the children in the 10 – 14-year age bracket experiencing symptoms as well as with 69% of the children in the 15 – 16-year age bracket. Contrary to the previous studies mentioned, associations such as phoria, tropia, stereopsis or computer usage were insignificant in eliciting asthenopic symptoms in the schoolchildren. Gender, race, and socioeconomic status also did not affect the prevalence of asthenopia. One reason in this study for the low prevalence of asthenopic symptoms, especially in younger children, were due to the fact that children do no report complaints of asthenopic symptoms as they are unaware of what it's like to read comfortably.

CHAPTER THREE: METHODOLOGY

Introduction

This chapter describes the processes which were undergone during data collection. It also takes into account the details of the research design, sample size determination, sampling technique utilized, the process of data collection and the process of data analysis. It briefly defines the details of ethical considerations. Furthermore, this chapter gives insight to the considerations for candidate inclusion and exclusion.

3.1 Ethical Consideration

- Ethical approval was obtained from the Ethics Committee of the University of the West Indies, St Augustine Campus,
- Permission was obtained from the Campus Principal and Campus Registrar to conduct research on the grounds of the University of the West Indies.
- Consent to participate in the study was obtained from each candidate prior to administering the questionnaires.
- All collected data was stored on a password protected computer only accessible to the co-investigators and private investigator.
- This study complied with the concerns outlined by the declaration of Helsinki (1964).

3.2 Research Design

This study is a prospective and descriptive, cross sectional study of the prevalence of asthenopia and asthenopic symptoms in a university setting. It utilizes stratified convenience sampling methods in order to obtain data which is representative of the total student population of the University of the West Indies, St. Augustine Campus.

3.3 Study Population

The population in this study includes all the undergraduate students between the ages of 18-30 years old in the University of the West Indies, St Augustine campus, Trinidad and Tobago.

3.3.1 Area of Study

Trinidad and Tobago are the two southernmost islands of the Caribbean Archipelago and are geological extensions of the South American Continent. Trinidad is located off the North-East Coast of Venezuela. Trinidad and Tobago span 1850 square miles and 115 squared miles respectively with 20 miles lying between them. [22]

The University of the West Indies constitutes the following campuses: [23]

- St. Augustine Campus, Trinidad and Tobago
- Cave Hill Campus, Barbados
- Mona Campus, Jamaica
- As well as 17 Open Campus locations across the Caribbean Archipelago.

This study was conducted at the University of the West Indies, St. Augustine Campus, Trinidad and Tobago.

3.3.2 Inclusion Criteria

Registered fulltime undergraduate students of the University of the West Indies, St Augustine campus, Trinidad and Tobago who are between the ages of 18-30 during the study were included.

3.3.3 Exclusion Criteria

UWI students with best corrected visual acuity (BCVA) of less than 20/ 25 in either eye, strabismus, ocular or systemic diseases affecting binocular vision, and using any medication that can impact accommodation or convergence were excluded

3.4 Sample Size and Sampling Technique

3.4.1 Sample Size Determination

The sample size was determined by using the total number of students at the St. Augustine Campus of the University of the West Indies. The student population was calculated to be 10,935 students.[24]

Raosoft Statistical Sample Size calculator was used to determine the sample size by inputting the study population of 10,935 individuals at a 95% Confidence Interval. Raosoft utilizes the formula:

$$“\ x=Z(^{c}/_{100})^{2}r(100-r)$$

$$n=^{N\,x}/_{((N-1)E^{2}+x)}$$

$$E=Sqrt[^{(N-n)x}/_{n(N-1)}]$$

where N is the population size, n is the fraction of responses of interest, and Z(c/100) is the critical value of the confidence interval.”

It was determined that 372 samples would need to be collected in order to satisfy the criteria of the population size of 10,935 individuals and a 95% CI. It was then assumed that there would be an 80% response rate. This indicates that for every 10 questionnaires distributed, only 8 would be completed. Thus, instead of distributing 372 questionnaires and only receiving 298 completed, the number of questionnaires distributed was increased to 456 questionnaires.

3.4.2 Sampling Technique

This study is cross sectional and the data collected is intended to represent the student population, as a result equal numbers of questionnaires were to be given to each faculty. The total number of questionnaires of 456 were divided by the seven faculties, giving an estimated 76 questionnaires to be distributed within each faculty. After all necessary legal and ethical concerns were addressed, the administrative assistant of each department was given a link to the questionnaire and asked to give questionnaires to the first 76 undergraduate students who were willing to participate.

3.5 Tests and Equipment

A modified version of a questionnaire developed and utilized by Kim et al[25] was used to evaluate asthenopia. The questionnaire consisted of 14 questions which related to demographics and general health, and a final multiple-choice grid question detailing 18 symptoms of asthenopia which were graded on a scale of 1 – 4 with 1 being none and 4 being severe.

3.6 Data Collection Procedure

- Ethical approval was granted before the commencement of any research data collection.
- Permission was sought from the Campus Registrar and by extension the respective ethical board acting on behalf of the Principal.
- The administrative assistant of each department was given a link to the questionnaire on Google Forms and asked to give 76 questionnaires to the first UG students who are willing to participate.

- Each Google form provided a consent form prior to accessing it. If the participant wished to partake in the study, they would select 'yes' where they would have been redirected to the questionnaire which they would proceed to fill out. If the participant declines, they would have clicked 'no' where the questionnaire would be terminated on proceeding.
- Participants that consent to this study yet meet the exclusion criteria will have their forms discarded from the analysis. This will be deduced from the replies of the patient in Section 3: General Eye Health of the questionnaire.
- During the period of January to April 2020, a total of 129 questionnaires was obtained. Of these, 27 questionnaires were disregarded having not met the inclusion criteria and 102 questionnaires met the inclusion criteria.
- Persons were considered to have experienced asthenopia if they reported experiencing four or more mild symptoms, two or more moderate symptoms or one severe symptom with at least one other symptom.

3.7 Data Analysis

Data was presented in the form of Tables. Descriptive Statistics were analysed using the Frequencies function to give an estimate of the frequency and prevalence of the symptoms of asthenopia between genders and age groups.

CHAPTER FOUR: RESULTS

This chapter shows the tabulated data gathered from the questionnaire. There consists a total of 7 tables, each containing data that will be used to answer the research questions of this study.

4.1 Prevalence of Asthenopia

Table 1 below shows the number of respondents diagnosed with asthenopia according to their demographics. Females have a general higher prevalence of asthenopia at 98.3% of their population compared to males at 68.2% of their population. Age does not seem to affect the prevalence of asthenopia whatsoever and spectacle wears are more likely to experience asthenopic symptoms as there was a prevalence of 96.4% compared to those that do not wear spectacles at 71.7%.

Table 1 Showing the number of respondents diagnosed with asthenopia

Variable	Subcategory	No. of Respondents	No. of Respondents Diagnosed with Asthenopia	% of Respondents Diagnosed with Asthenopia
Gender	Male	44	30	68.2
	Female	58	57	98.3
Age	18 – 24	95	81	85.3
	25 – 30	7	6	85.7
Spectacle Wear	Yes	56	54	96.4
	No	46	33	71.7
Hours of phone usage	0 – 2 hours	0	0	0
	2 – 4 hours	22	13	59.1
	4 – 6 hours	31	28	90.4
	>6 hours	49	46	93.9
Hours spent Reading	0 – 2 hours	33	29	87.0
	2 – 4 hours	36	31	86.1
	4 – 6 hours	20	16	80.0
	>6 hours	13	11	84.6
Overall No. of Respondents per Variable		102	87	85.3

4.2 Symptoms of Asthenopia

Table 2 below shows the prevalence of asthenopic symptoms experienced by the respondents, with the most prevalent symptom being eye fatigue at near at 64.7% and the least prevalent symptom being difficulty tracking objects at near at 15.7%. The percentages here are not cumulative, as respondents can have either one or more of these symptoms at a time.

Table 2 Showing the prevalence of asthenopic symptoms among respondents.

Asthenopic Symptoms	n	%
Headaches @ Near	59	57.8
Headaches @ Far	32	31.4
Eye Fatigue @ Near	66	64.7
Eye Fatigue @ Far	41	40.2
Eye Pain @ Near	34	30.0
Eye Pain @ Far	21	20.6
Eye Strain @ Near	52	51.0
Eye Strain @ Far	45	44.1
Blurry Vision @ Near	32	31.4
Blurry Vision @ Far	55	53.9
Seeing Double @ Near	20	19.6
Seeing Double @ Far	20	19.6
Difficulty Tracking Objects @ Near	16	15.7
Difficulty Tracking Objects @ Far	36	35.3
Watering Eyes	58	56.9
Burning Eyes	54	52.9
Itching Eyes	50	49.0
Dry Eyes	56	54.9

4.3 The Distribution of Asthenopia

Table 3 below shows the frequency of asthenopic symptoms according to gender from a total of 58 females and 44 males. The most prevalent symptoms were found to be eye fatigue at near at 68.2% and blurry vision at far at 65.5% respectively for male and female respectively, and the least prevalent symptoms were found to be eye pain at far at 11.4% and difficulty tracking objects at far at 13.8% for male and female respectively. The percentages here are not

cumulative, as respondents of each gender can have either one or more of these symptoms at a time.

Table 3 Showing the frequency of asthenopic symptoms according to gender.

Asthenopic Symptoms	Male		Female	
	n	%	n	%
Headaches @ Near	22	50	37	63.8
Headaches @ Far	9	20.5	23	39.7
Eye Fatigue @ Near	30	68.2	36	62.1
Eye Fatigue @ Far	13	29.5	28	48.3
Eye Pain @ Near	13	29.5	21	36.2
Eye Pain @ Far	5	11.4	16	27.6
Eye Strain @ Near	23	52.3	29	50.0
Eye Strain @ Far	14	31.8	31	53.4
Blurry Vision @ Near	13	29.5	19	32.8
Blurry Vision @ Far	17	38.6	38	65.5
Seeing Double @ Near	8	18.2	12	20.7
Seeing Double @ Far	7	15.9	13	22.4
Difficulty Tracking Objects @ Near	8	18.2	8	13.8
Difficulty Tracking Objects @ Far	12	27.3	24	41.4
Watering Eyes	21	47.7	37	63.8
Burning Eyes	21	47.7	33	56.9
Itching Eyes	17	38.6	33	56.9
Dry Eyes	20	45.5	36	62.1

Table 4 below shows the frequency of asthenopic symptoms according to age. The 18 – 24 year category comprised of 95 people whereas the 25-30 year category comprised of 7 people. The most prevalent symptoms were found to be eye fatigue at near at 62.1% and blurry vision and headaches at near both at 71.4% for the age groups of 18 – 24 years and 25 – 30 years respectively. The least prevalent symptoms were found to be difficulty tracking objects at near at 12.6% and eye strain at far at 14.3% for the age groups of 18 – 24 years and 25 – 30 years respectively. The percentages here are not cumulative, as respondents of each age group can have either one or more of these symptoms at a time.

Table 4 Showing the frequency of asthenopic symptoms according to age.

Asthenopic Symptoms	18 – 24 years		25 – 30 years	
	n	%	n	%
Headaches @ Near	54	56.8	5	71.4
Headaches @ Far	32	33.7	0	0
Eye Fatigue @ Near	59	62.1	7	100.0
Eye Fatigue @ Far	39	41.1	2	28.6
Eye Pain @ Near	31	32.6	3	42.9
Eye Pain @ Far	21	22.1	0	0
Eye Strain @ Near	46	48.4	6	85.7
Eye Strain @ Far	44	46.3	1	14.3
Blurry Vision @ Near	27	28.4	5	71.4
Blurry Vision @ Far	55	57.9	0	0
Seeing Double @ Near	16	16.8	4	57.1
Seeing Double @ Far	20	21.1	0	0
Difficulty Tracking Objects @ Near	12	12.6	4	57.1
Difficulty Tracking Objects @ Far	35	36.8	3	42.9
Watering Eyes	55	57.9	4	57.1
Burning Eyes	50	52.6	4	57.1
Itching Eyes	50	52.6	0	0
Dry Eyes	54	56.8	2	28.6

4.3 Associated Factors of Asthenopia

Table 5 below shows the frequency of asthenopic symptoms between spectacle wearers, comprising of 56 people, and non-wearers comprising of 46 people. The most prevalent symptoms were found to be blurry vision at far at 71.4% and both headaches at near and eye fatigue at near at 60.9% in wearers and non-wearers respectively. The least prevalent symptoms were found to be difficulty tracking objects at near at 17.9% and seeing double at far at 10.9% for wearers and non-wearers respectively. The percentages here are not cumulative, as wearers and non-wearers can have either one or more of these symptoms at a time.

Table 5 Showing the frequency of asthenopic symptoms according to spectacle wear.

Asthenopic Symptoms	Wears Spectacles		No Spectacles	
	n	%	n	%
Headaches @ Near	31	55.4	28	60.9
Headaches @ Far	23	41.1	9	19.5
Eye Fatigue @ Near	38	67.9	28	60.9
Eye Fatigue @ Far	34	60.1	7	15.2
Eye Pain @ Near	20	35.7	14	30.4
Eye Pain @ Far	14	25.0	7	15.2
Eye Strain @ Near	33	58.9	19	41.3
Eye Strain @ Far	32	57.1	13	28.3
Blurry Vision @ Near	19	33.9	13	28.3
Blurry Vision @ Far	40	71.4	15	32.6
Seeing Double @ Near	11	19.6	9	19.5
Seeing Double @ Far	15	26.8	5	10.9
Difficulty Tracking Objects @ Near	10	17.9	6	13.0
Difficulty Tracking Objects @ Far	30	53.6	6	13.0
Watering Eyes	33	58.9	25	54.3
Burning Eyes	33	58.9	21	45.7
Itching Eyes	26	46.4	24	52.2
Dry Eyes	31	55.4	25	54.3

4.4 Causes of Asthenopia

Table 6 below shows the frequency of asthenopic symptoms according to hours of device usage. In the case of this, the two extremes from the questionnaire were used in order to provide a suitable contrast in symptoms according to time. There were no responses in the 0 – 2 hour category hence the 2 – 4 hour category was used. The most prevalent symptoms were found to be headaches at near at 54% and both eye fatigue at near and watery eyes at 73.9% between the 2 – 4 hour and >6 hour categories respectively. The least prevalent symptoms were found to be both eye fatigue at far and eye pain at far at 9% and difficulty tracking objects at near at 13% between the 2 – 4 hour and >6 hour categories respectively. The percentages here are not cumulative, as respondents can have either one or more of these symptoms at a time.

Table 6 Showing the frequency of asthenopic symptoms according to device usage.

Asthenopic Symptoms	2 – 4 Hours Using Devices		> 6 Hours Using Devices	
	n	%	n	%
Headaches @ Near	12	54.0	27	58.7
Headaches @ Far	4	18.0	19	41.3
Eye Fatigue @ Near	11	50.0	34	73.9
Eye Fatigue @ Far	2	9.0	24	52.2
Eye Pain @ Near	3	13.6	24	52.2
Eye Pain @ Far	2	9.0	12	26.1
Eye Strain @ Near	8	36.0	31	67.4
Eye Strain @ Far	5	22.7	24	52.2
Blurry Vision @ Near	4	18.0	20	43.5
Blurry Vision @ Far	7	31.8	27	58.7
Seeing Double @ Near	5	22.7	7	15.2
Seeing Double @ Far	3	13.6	11	23.9
Difficulty Tracking Objects @ Near	3	13.6	6	13.0
Difficulty Tracking Objects @ Far	5	22.7	19	41.3
Watering Eyes	9	40.9	34	73.9
Burning Eyes	9	40.9	30	65.2
Itching Eyes	7	31.8	28	60.9
Dry Eyes	8	36.0	32	69.6

Table 7 below shows the frequency of asthenopic symptoms according to hours spent reading. In the case of this, the two extremes from the questionnaire was used in order to provide a suitable contrast in symptoms according to time. The most prevalent symptoms were found to be dry eyes at 71.9% and headaches at near at 84.6% between the 0 – 2 hour and >6 hour categories respectively. The least prevalent symptoms were found to be difficulty tracking objects at far at 12.5% and seeing double at far at 7.7% between the 0 – 2 hour and >6 hour categories respectively. The Percentages here are not cumulative, as respondents can have either one or more of these symptoms at a time.

Table 7 Showing the frequency of asthenopic symptoms according to hours spend reading.

Asthenopic Symptoms	0 – 2 Hours Reading		> 6 Hours Reading	
	n	%	n	%
Headaches @ Near	13	40.6	11	84.6
Headaches @ Far	9	28.1	5	38.5
Eye Fatigue @ Near	22	68.8	10	76.9
Eye Fatigue @ Far	14	43.8	6	46.2
Eye Pain @ Near	10	31.3	3	23.1
Eye Pain @ Far	7	21.9	3	23.1
Eye Strain @ Near	16	50.0	4	30.8
Eye Strain @ Far	17	53.1	7	53.8
Blurry Vision @ Near	10	31.3	4	30.6
Blurry Vision @ Far	20	62.5	9	69.2
Seeing Double @ Near	6	18.8	2	15.4
Seeing Double @ Far	9	28.1	1	7.7
Difficulty Tracking Objects @ Near	5	15.6	0	0
Difficulty Tracking Objects @ Far	4	12.5	2	15.5
Watering Eyes	17	53.1	8	61.5
Burning Eyes	16	50.0	5	38.5
Itching Eyes	16	50.0	6	46.2
Dry Eyes	23	71.9	3	23.1

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

A total of 129 responses were acquired, of which 102 met the inclusion criteria and were used for the analysis of data in this study. Respondents were considered asthenopic if they experienced the either of the following severities of symptoms:

- Four or more mild symptoms
- Two or more moderate symptoms
- One severe symptom with at least one other symptom

5.1.1 Prevalence of Asthenopia

Of the 102 respondents that met the inclusion criteria, 87 experienced asthenopic symptoms which reflects an 85.3% prevalence among the undergraduate students of the University of the West Indies. This value is noticeably higher than that of a similar study done on university students in Iran by Hashemi et al [13] where 71.2% of respondents experienced asthenopic symptoms. Of the respondents, 44 were male and 58 were female, where 68.2% (30) and 98.3% (57) of each respective gender experienced asthenopic symptoms. This large discrepancy in prevalence between genders may be reflected in Table 3 which shows that females have a greater tendency to experience asthenopic symptoms compared to males. This may be because women are more emotionally expressive and may be more sensitive to these symptoms when compared to men.[27] It was observed that age did not have much of an influence on the distribution of these symptoms however as 85.7% of those in the 18 – 24 year age bracket had a similar prevalence to the 25 – 30 year age bracket of 85.3% (Table 1). The prevalence of asthenopia among these year groups were similar to that of a study done on a Brazilian population by Schellini et al [21] where 85.9% participants in their second decade of life experienced these symptoms. It was suggested by Han et al [6] that the number of people affected by asthenopia will rise drastically in the future. This statement may correlate with the findings in this study, as there was a marked increase in prevalence from 57% in the study done by Han et al [6] in 2013 to 71.2% in the study done by Hashemi et al [13] in 2019.

5.1.2 Symptoms of Asthenopia

The most prevalent asthenopic symptoms were eye fatigue during near work at 64.7% (66), headaches during near work at 57.8% (59) and watery eyes at 56.9% (58). These results were slightly higher than the study done by Al Subaie et al [14] where, under similar conditions to that of university students, the most frequent symptoms were headaches at 52.4% and eye strain at 44.7%. Symptoms of eye strain in this study were experienced by 51% of respondents which is also slightly higher than that of the study discussed. The prevalence of headaches was similar to that of another study done by Darko-Takyi et al [18] which showed that 61.8% of students experienced headaches however only 20% experienced eye strain. Perhaps maybe in this project, the respondents may not have been able to tell the difference between eye strain and eye fatigue hence the higher values for eye fatigue than eye strain as there is a vague distinction between the two.

5.1.3 Associated Factors of Asthenopia

The study by Darko-Takyi et al [18] found that there was a high association between spectacle wear and accommodative insufficiency. It was also noted by Deshmukh et al [19] that persons suffering from accommodative insufficiency had a higher tendency to experience asthenopic symptoms. Unfortunately, refractive error and other objective tests for binocular abnormalities could not have been performed during this research due to a restriction imposed by the ethical committee of the University of the West Indies. The questionnaire used did however include questions pertaining to spectacle wearers in which results were compared to non-wearers with respect to the prevalence of asthenopic symptoms seen in Table 5 where, aside from headaches during near activities, spectacle wearers generally experienced more symptoms than non-wearers, and if considering Darko-Takyi et al [18] it could potentially be due to the presence of accommodative insufficiency or other present binocular abnormalities. It was also observed that 96.4% (54) of all spectacle wearers in this study were diagnosed with asthenopia compared to 71.7% (33) of all non-wearers (Table 1).

5.1.4 Causes of Asthenopia

Exposure to electronic devices with screens are said to be one of the major causes of asthenopic symptoms as outlined by Vilela et al [17] and Vaz et al.[16] This can be seen in Table 6 which shows the frequency of symptoms experienced by those that used these devices for 2 – 4 hours and those that used them for >6 hours. Generally, for all symptoms except headaches during near work, those who used devices for >6 hours had a greater tendency to experience asthenopic symptoms than those that used it for less. This is similar to that of a study done on a company in Portugal by Vaz et al [16] where a group with <2 hours of exposure was compared to another with >2 hours of exposure to these devices showed that the latter group were more symptomatic than the former. Results were mixed when it came to near activities involving the use of printed material, where those that read material for 0 – 2 hours experienced less symptoms of headaches and eye fatigue yet experienced more symptoms of seeing double, burning, itchy and dry eyes than those that read printed material for >6. The only explanation in this instance may have been the perception of time for the respondents, as one may be more incline to sit and read for 2 hours without breaks and thus experience symptoms of dryness or burning compared to those that read for >6 hours who more than likely take breaks in between. Due to the excessive amount of reading over a long period of time, it may be more common for those that read for >6 hours to experience headaches and eye fatigue despite taking breaks. It can thus be suggested that extended usage of electronic devices can cause and/ or exacerbate symptoms of asthenopia.

5.1.5 Demographics of Asthenopia

From the 102 respondents, 44 were male and 58 were female. Of the female population, a total of 93.8% (57) were positive for asthenopic symptoms. However, of the male population, 68.2% (30) were positive for asthenopia. This shows a 25.6% difference between the populations. The most recorded asthenopic symptoms of the male population were eye fatigue (68.2%), eyestrain (52.3%) and headaches at near (50%) whereas for females the most reported symptoms were blurry vision at far (65.5%), watery eyes (63.8%) and headaches at near (63.8%) (Table 3). Contrary to this study, Schellini et al [21] concluded that there was no significant difference in the rate of asthenopia in the male and female population since the

male and female population had a prevalence of 55.8% and 61.8% respectively which were considered to be closely distributed. Vilela et al [17] on the other hand stated that 5 out of the 22 studies they analysed claimed that asthenopia affected females more.

The 18 – 24 age group accounted for 95 of the respondents whereas the 25 – 30 age group only accounted for 7. The 18 – 24 age group had a prevalence of 85.3% whereas the 25 – 30 age group had a prevalence of 85.7%. which suggests that age may not contribute to experiencing asthenopic symptoms. There are similarities in the type of asthenopic symptoms experienced by both age groups. Headaches at near 56.8% and 71.4% respectively for the 18 – 24 and 25 – 30 age groups and eye fatigue at near at 62.1% and 100% respectively. However, the 18 – 24 age group experienced blurry vision in the distance whereas the 25 – 30 age group experienced more near complications such as blurry vision and eyestrain when focusing at near. Schellini et al [21] contradicted the findings in this study yet again as they concluded that age did in fact play an important role in developing asthenopia, where younger persons were at a greater risk of developing asthenopia. However, it was also noted that older patients were more prone to experiencing near symptoms than younger patients due to the effect of presbyopia.

5.2 Conclusion

It was found that 85.3% of undergraduate university students experienced asthenopic symptoms. The most common symptoms recorded were eye fatigue and headaches during near work at 64.7% and 57.8% respectively, and watery eyes at 56.9%. Asthenopia was also recorded in 98.3% (57) of the female population and in 68.2% (30) of the male population. It was observed that spectacle wear may be an associated factor of asthenopia and that prolonged use of electronic devices with displays may cause users to experience asthenopic symptoms.

5.3 Recommendations

This research can be greatly improved upon if the following recommendations are taken into consideration:

- Larger sample count – Only 129 responses were acquired in total with 102 meeting the inclusion criteria. The initial sample size was 372 however due to time constraints and the unforeseen COVID-19 outbreak, data collection was affected. Instead of strictly undergraduate students, post-graduate and off-campus students could have also been considered to increase the sample size and age groups.
- Objective results from each respondent – to test associated factors such as astigmatism and binocular abnormalities via practical examinations which was a major limitation in this project. The causes of asthenopia considered in this project was also limited, as not much data was available and thus the more values we may have obtained, the more associated factors could have been considered. The symptoms gathered from the questionnaire may not necessarily be related to asthenopia and can be associated with ocular surface diseases and an objective assessment can help identify this.
- Broaden the spectrum of the causes of asthenopia – Asthenopia may not exclusively be caused by ocular problems. Environmental conditions also play a role in developing asthenopic symptoms such as lighting as well as ergonomics and posture. Living conditions could have been an option in the questionnaire to identify this.
- More studies like this should be done within the Caribbean – This would allow studies on asthenopia to be compared between countries with a similar ethical makeup as most of the resources cited in this project are from areas on the eastern side of the world. Studies done in the Caribbean can also explore environmental conditions and their effects on asthenopia for instance humidity as it may be drastically different from the conditions in Iran or China where some of these studies were performed.

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