The Relationship Between Dry Eye Disease and Myopia with the Increased Use of Digital Devices in Adolescents

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Acknowledgements

I would like to acknowledge my teachers, Mrs. Flanagan and Mrs. Puopolo for their continual guidance throughout my research. I would also like to thank my mentors, Dr. Christopher Taylor and Dr. Sirtaz Sibia for their assistance in this research, and both of my parents for their help and support.

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Abstract

Adolescents know their surrounding world through a digital screen. Electronic device use has become a fundamental part of daily life, including educational and leisure settings. The influence of the COVID-19 Pandemic has caused an even greater use of electronics as many schools switched to online learning. Screen-based lifestyles have ultimately led to a concern for ocular health. Previous studies have indicated that excessive screen time is associated with negative impacts on adolescents' lives. As the children's visual system continues to evolve, the use of electronic screens has become a major concern. Dry eye symptoms and myopic progression are beginning to increase as extended screen time increases. The purpose of this study was to determine the relationship between both dry eye disease and myopia with the increased use of digital devices. A Google Forms survey was administered to students in Monroe Woodbury High School and Monroe Woodbury Middle School through email from administration. Of the 260 participants, 66.5% reported their eyes "sometimes" feeling tired, fatigued, or strained after work on electronic devices. The study found a positive correlation between the amount of hours spent per day on electronic devices and frequency and severity of symptoms, specifically tiredness/fatigue. The use of electronic devices is an essential part of adolescent lifestyle and preventative measures should be taken.

Introduction

Almost all of society has become reliant on digital devices for everyday tasks. The use of electronic screens has increased dramatically in the past 5-10 years (van Tilborg MM., 2017), and the increasing reliance on them poses major health issues. The amount of time individuals spend on the internet rises daily, especially in adolescents. They now know their surrounding world through a digital screen, which has led to a development in behavior change across different generations. In modern society, eye disorders in children are considered to be one of the most significant medical and social problems (Filknia, 2020). As technology continues to become more prevalent throughout society, it is becoming more challenging for people to spend time away from their devices and relax their eyes.

The COVID-19 Pandemic caused multiple lockdowns throughout the world, which has greatly contributed to the continuous use of electronic devices, as many schools have switched to online E-learning. The extended exposure on digital devices may have caused long term impacts on vision development in adolescents. Many students began using their devices for school and leisure time, which caused excessive digital device use which may become a big risk factor for the development of myopia as well as dry eye disease. Taking breaks away from the screen has become increasingly challenging, as well as caused a prevalence of interrupted sleep patterns. Children's eyes take in more blue light than adults. Almost all visible blue light focuses at the retina which may disturb eyesight and age the eyes at a faster rate (Qasim et al., 2021).

Dry eye disease is a common condition that occurs when your eyes do not produce enough tears and your tears aren't able to provide adequate lubrication to your eyes. This can often lead to discomfort, itchy, or irritated eyes. Studies have found that long-term computer usage may cause an evaporative-type dry eye disease (Akkaya and Atakan, 2018). Long periods of focused screen

time may lead to incomplete eye blinking and therefore, may result in dry eyes. (Mineshita et al., 2021) The long term effects of digital device use could be extremely damaging on vision, and exploring this concern could allow people to change the amount of time they spend on screens.

Myopia (nearsightedness) is a condition in which close objects appear clearly, but objects far away do not. Studies have shown that excessive screen time may increase the risk of myopia by nearly 80% in children (Huang, 2015). It is estimated that by 2050, 59.6% of the world's population will become myopia (Saw SM, 2019). The increase of myopia is a matter of serious public health concern (WHO, 2015). The prevalence of adolescent myopia in regional cities has increased rapidly over the past 50-60 years, in some cases with 80-90% of high school students being myopic (Liu, 2021). The adolescent eye is still developing, which means that spending long periods of time looking at electronic screens close to the eye can result in extended exposure in hyperopic defocus. The refractive vision is then altered which leads to it developing prematurely.

Digital screen use has become a leading risk factor for causing vision disorder among children (Mohan, 2020). Since the COVID-19 pandemic many adolescents began complaining of blurred vision, excessive watering, irritation/itching, and headache. This prompted me to design this questionnaire-based survey.

Purpose

The purpose of this study aims at focusing on the effects of electronic screens on adolescents eyes after the COVID-19 pandemic, specifically the relationship between both dry eye disease and myopia with the increased use of digital devices. It was hypothesized that there would be a significant increase in ocular discomfort as screen time increased based on past research.

Methodology

Participants in this study were obtained from Monroe-Woodbury High School and Monroe-woodbury Middle School. All participants were from the ages of 10 to 19 and had access to a digital device to be able to complete the online survey. The Google Forms survey was sent through email from administration to all students, and parental consent was required. The students had the option of participating, as the survey was completely voluntary. The participants' responses were all anonymous, which included email addresses. Participants were allowed to stop or withdraw their surveys at any time.

The online survey consisted of four sections: demographic information, electronic screen use, Myopia and Dry Eye symptoms, and preventative measures that can be taken to lower the long term damage. The experimental group consisted of adolescents with symptoms or a diagnosis of dry eye disease and/or myopia, and the control group consisted of adolescents who had not been diagnosed with nor have symptoms of dry eye disease and or myopia.

An original survey **(Appendix 1)** was then administered. Information was collected on age and gender to compare the prevalence. The use of glasses and contacts was also addressed in the survey to rule out the limitation of prescriptions having an effect on the impact of device usage on eye health. Myopia symptoms were collected on a scale of never to always, and scores with multiple "often" and "always" meant that there were symptoms of myopia. Dry eye symptoms were collected through a frequency of eye symptoms on a scale of 0-3 and a severity of symptoms on a scale of 0-3. Participants who scored mostly 2's and 3's showed symptoms of Dry eye disease.

The fourth section focused on preventative measures that can be taken for adolescents who feel they have gained ocular issues from their electronic screens. Participants were advised to seek medical attention if they feel that they have many of the symptoms or their eyesight has declined.

Data was collected from August 29th, 2023 to November 1st, 2023. Results were transferred to Google Sheets for analysis.

Results

There were 260 participants (mean age of 13.93) in total who completed the survey, five of which were excluded because they did not follow the criteria of the survey and left incomplete data. The largest age group, 23.5% of the participants, who completed the survey were thirteen year olds (n=61). Of the total 260 participants, 65% of the participants were females. (n=169). Under half of the participants, 42.7%, reported that they wear glasses/contact lenses permanently. The mean age for how long the participants that wear contacts/glasses is 8.5 years old. Out of the 111 participants who wear glasses/contacts permanently, 72 of them have seen a change in their prescription since the COVID-19 Pandemic. This result could be related to the increased use of electronic devices during the pandemic, which ultimately caused participants' vision to decline.

Figure 1

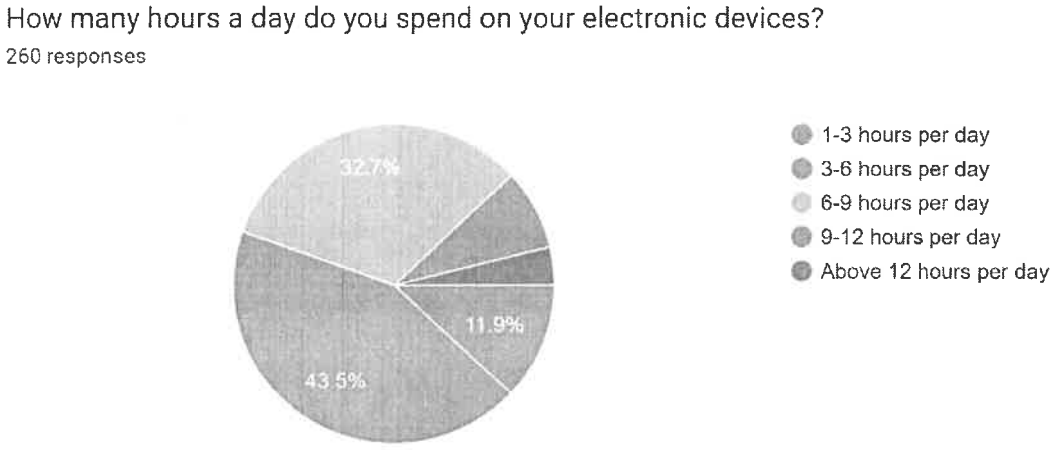

Figure 2

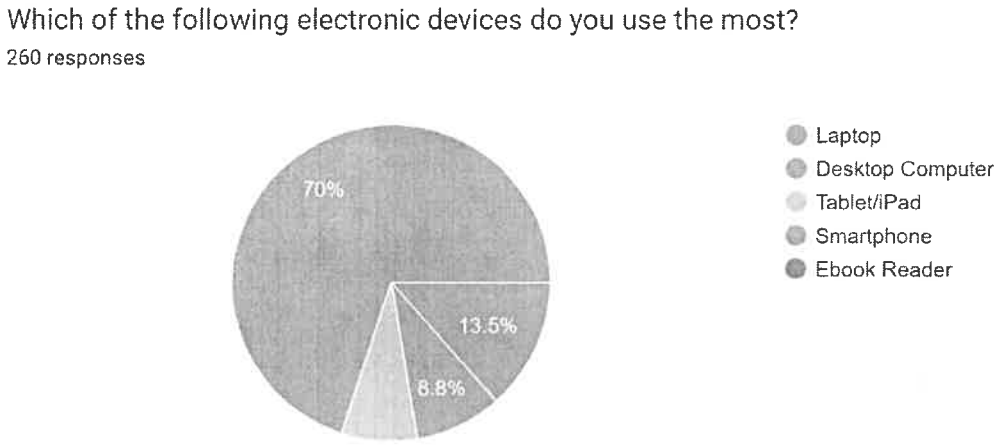

Figure 3

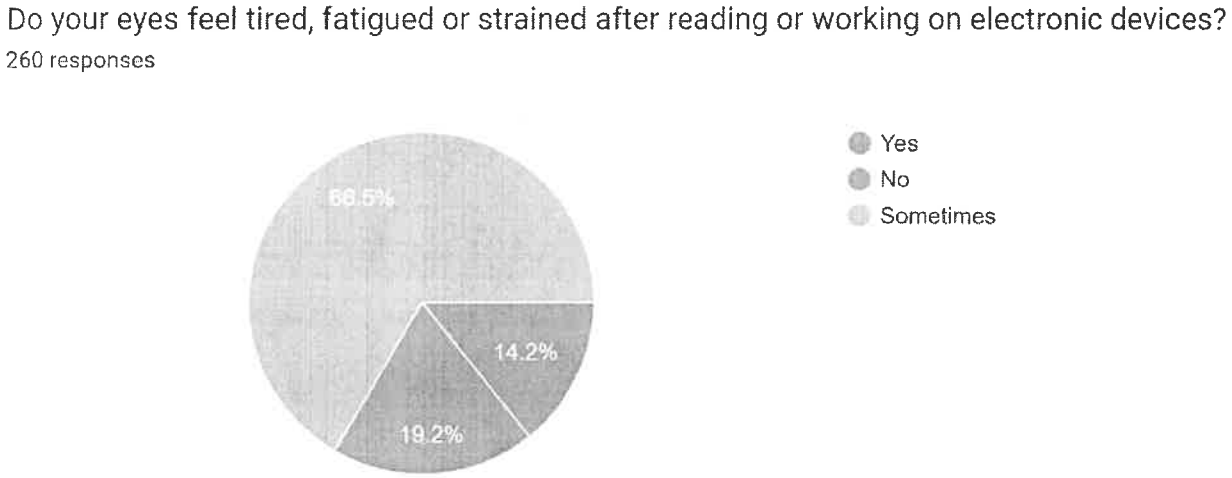

Figure 1 represents the highest amount of hours per day participants spent on their electronic devices were 3-6 hours (43.5%), which is over the recommended time of 2.5 hours per day. The most used digital device is shown in **Figure 2**, with smartphones at 70% of the participants. This could also be attributed to decreased eye health as participants are spending time staring at a screen that is close distance to their eyes. This action repeated many times may lead to

nearsightedness. **Figure 3** shows that 66.5% of participants' eyes "sometimes" feel tired, fatigued or strained after reading or working on electronic devices.

Figure 4

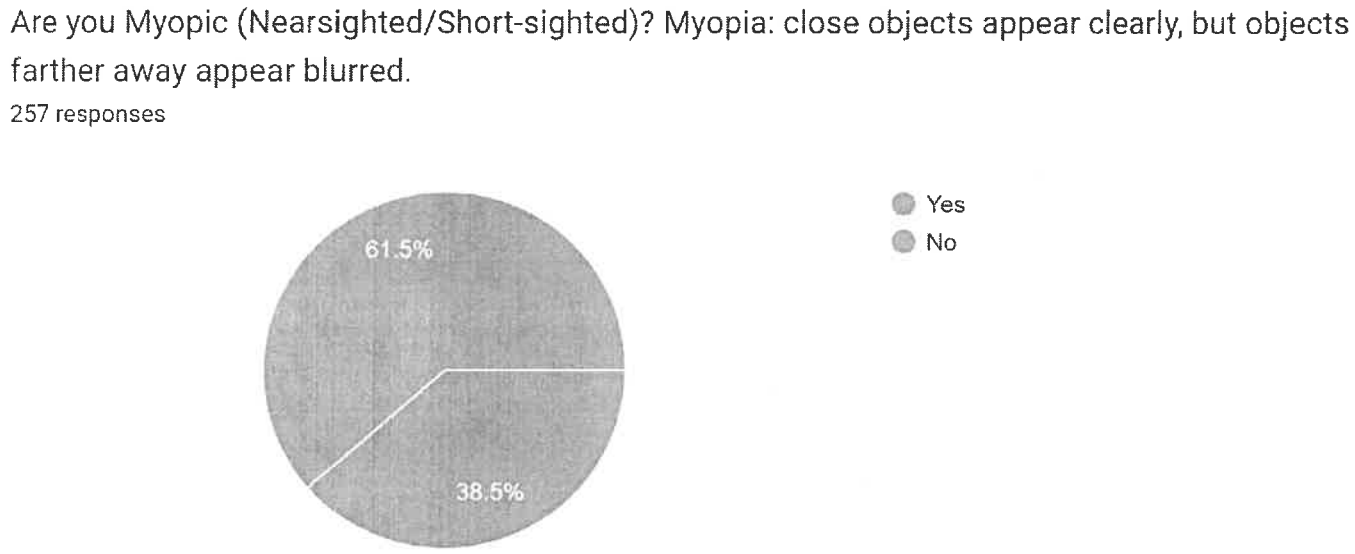

Figure 5

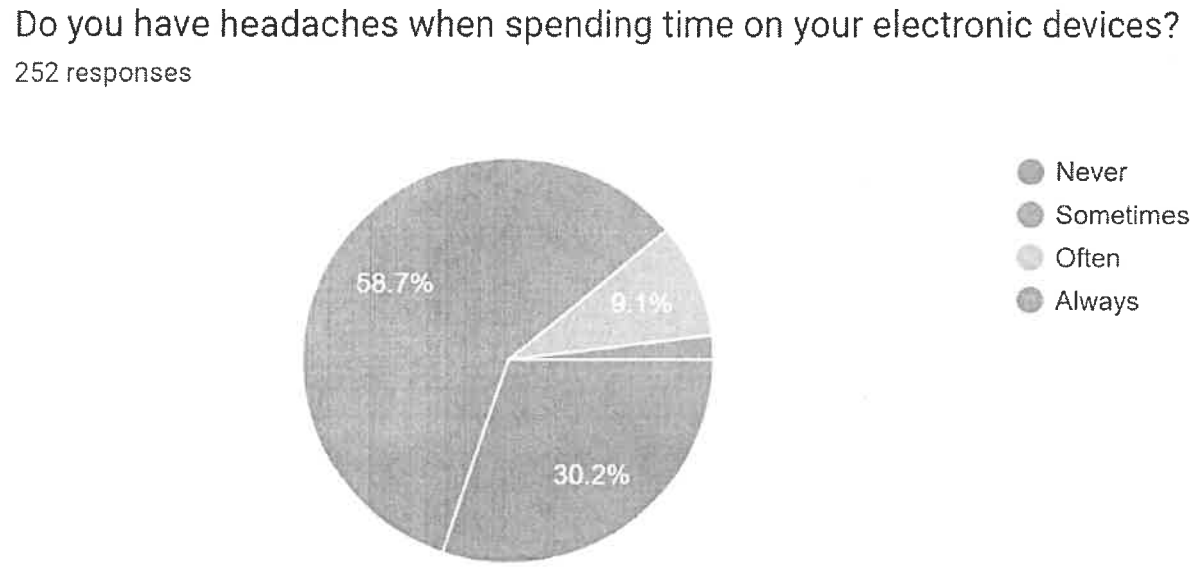

Figure 4 represents that 61.5% of the participants were already myopic. **Figure 5** shows that 58.7% of the total participants "sometimes" had headaches when spending time on their electronic devices. This shows a positive correlation between participants who reported having headaches when spending time on electronic devices and participants who reported having myopia.

Figure 6

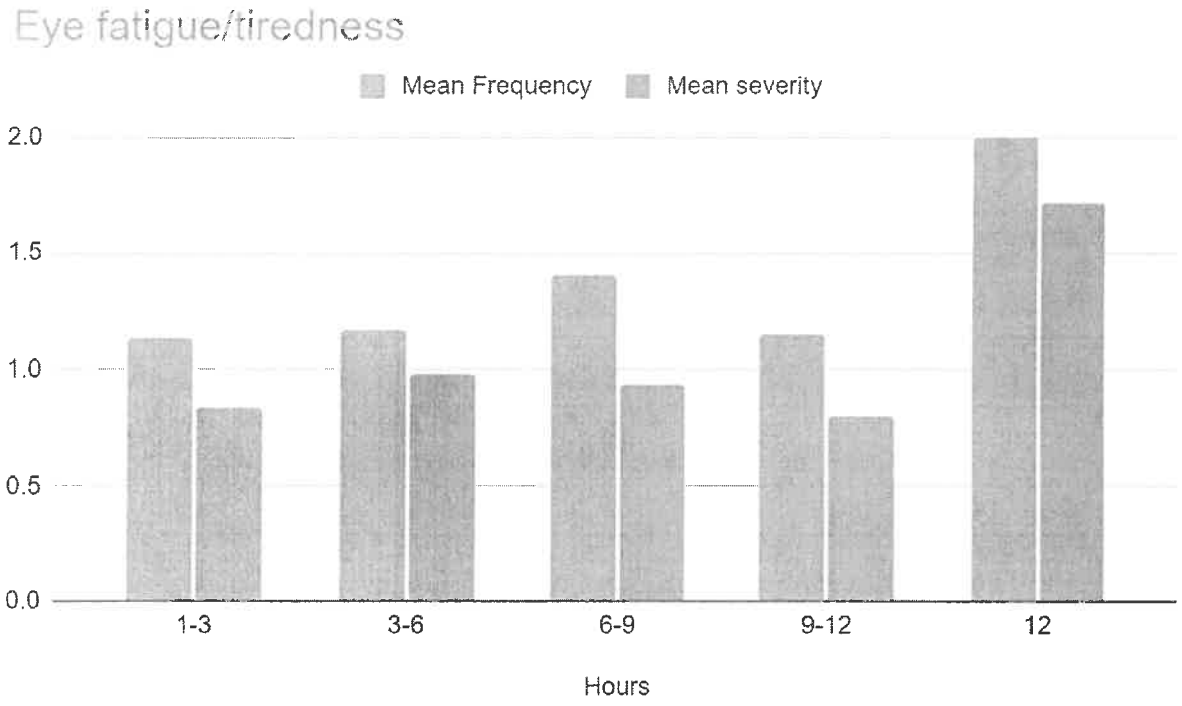

Figure 6 represents the mean frequency and mean severities for each set of hours spent on digital devices. The bar graph shows that as the hours spent on electronic devices increases, both the frequency and severity of eye fatigue/tiredness increases as well. Eye fatigue/tiredness is one of the many symptoms of dye Eye disease. Out of all the symptoms from the survey, eye fatigue/tiredness had the greatest impact on adolescents' eyes. 46.7% of participants said they had a frequency of eye fatigue/tiredness "sometimes", and 50.6% of participants said they had a severity of "uncomfortable". This correlation supports that spending long periods of time staring at electronic devices may lead to ocular issues such as dry Eye disease.

These values represent continuous data for mean frequency and mean severity within each time interval. When using Pearson correlation analysis, the correlation between the amount of hours and the mean frequency was $r = 0.953$, which represents that there is a strong positive correlation.($p= 0.0$) The correlation between the hours and the mean severity was $r = 0.980$, which represents that there is an even stronger positive correlation.($p= 0.0$) The positive correlation between screen time usage and eye fatigue/tiredness implies that as the number of hours spent on electronic devices increases, the frequency and severity of symptoms increases as well.

Discussion

The results imply that as the amount of time adolescents spend on their electronic devices increases, the risk of long term damage grows as well. A large portion of the adolescent population explored in the study answered questions with "never" and "sometimes" or zeros and ones. Participants reported having common symptoms of headache and tiredness. Duration of screen usage did not have a correlation between gender and age. 92% of participants stated that they use their electronic devices for social networking. The severity of dry eye disease symptoms did not vary significantly based on participants who wore glasses/contacts or not. Many participants who stated that they did wear glasses/contacts, also stated that they saw a change in their prescription since the COIVD-19 Pandemic. The increased use of electronic devices may have had a correlation with the change in prescription.

This study was self-administered which serves as a limitation in this study, as participants were able to self diagnose if they were myopic and their severity of dry eye symptoms. Additionally, screen time use was an estimate based on recall and was not objectively measured. Participants may not have been able to calculate the exact amount of time they spent on the

electronic devices, which serves as a limitation. The study relied on adolescents' answers, and many may have had difficulties in accurately self-reporting certain information.

Conclusion

The hypothesis was partially supported. Severe symptoms did not correlate directly to the increased use of electronic devices, but symptoms such as headache and tiredness did. Electronic screen use is part of everyday life and is going to continue to be used more for both in school and leisure activities. The increased use of electronic devices brings a new challenge of dry eye disease at an early age and poses the threat for long term damage. Symptoms of myopia and Dry eye disease due to prolonged screen time have increased since the COVID-19 Pandemic. Prevention of dry eye disease may involve deliberately blinking the eyes and allowing the eyes time to blink naturally.

Awareness efforts to reduce the rate of controllable risk factors should be considered. The use of electronic devices is an essential part of adolescent lifestyle and preventative measures should be taken. Further research is needed to inform on optimal strategies for myopia and dry eye disease in individuals with high use of digital devices.

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Appendix 1

Effect of Electronic Screens on Adolescent's Eye Health

Please answer all questions to the best of your ability.

* Indicates required question

1. Disclaimer: All names, emails, and personal information will remain anonymous throughout this survey. I will not be able to access any of this information. *

   Participation in this study is completely voluntary. There will be no negative consequences if you decide not to participate, stop participating, or refuse to answer any question.

   By checking yes on the box below, I, the participant, am attesting that I have read and understand the information above and I freely give my consent/assent to participate.

   Check all that apply

   ☐ Yes

2. Disclaimer: All names, emails, and personal information will remain anonymous throughout this survey. I will not be able to access any of this information. *

   Participation in this study is completely voluntary. There will be no negative consequences if you decide not to participate, stop participating, or refuse to answer any question.

   Because this study involves participants under 18, parental consent must be given. This box must be checked by a **parent/guardian**. By checking this box, I, the parent/guardian, am attesting that I have read and understand the information above and I freely give my consent/assent to participate or permission for my child to participate.

   Check all that apply.

   ☐ Yes

3. How old are you? *

Mark only one oval.

- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19

4. To which gender identity do you most identify? *

Mark only one oval.

- Male
- Female
- Prefer not to say

5. Do you wear glasses/contact lenses permanently? *

Mark only one oval.

- Yes
- No

6. If Yes, since what age have you been wearing glasses/contact lenses?

____

7. If Yes, have you seen a change in your prescription since the COVID-19 Pandemic?

Mark only one oval.

- Yes
- No
- N/A

Electronic Screen Use

Please answer all questions to the best of your ability.

8. How many hours a day do you spend on your electronic devices? *

Mark only one oval.

- 1-3 hours per day
- 3-6 hours per day
- 6-9 hours per day
- 9-12 hours per day
- Above 12 hours per day

9. Which of the following electronic devices do you use the most? *

Mark only one oval.

- ◯ Laptop
- ◯ Desktop Computer
- ◯ Tablet/iPad
- ◯ Smartphone
- ◯ Ebook Reader

10. For what purposes do you use these devices? *select all that apply *

Check all that apply.

- ☐ Social Networking
- ☐ School Work/ School Projects
- ☐ Reading ebooks
- ☐ Watching movies/videos
- ☐ Gaming
- ☐ Other: ____________________

11. Do your eyes feel tired, fatigued or strained after reading or working on electronic devices? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Sometimes

Myopia and Dry Eye Symptoms

Please answer all questions to the best of your ability.

12. Are you Myopic (Nearsighted/Short-sighted)? *

Myopia: close objects appear clearly, but objects farther away appear blurred.

Mark only one oval.

- Yes
- No

13. If Yes, at what age were you first diagnosed with myopia?

____

14. Do you have blurry vision when looking at distant objects?

Mark only one oval.

- Never
- Sometimes
- Often
- Always

15. Do you have headaches when spending time on your electronic devices?

Mark only one oval.

- Never
- Sometimes
- Often
- Always

16. Do you feel a "pulling" feeling around your eyes when spending time on your electronic devices?

Mark only one oval.

- Never
- Sometimes
- Often
- Always

Chose the frequency of your eye symptoms on a scale of 0-3

0= Never, 1=Sometimes, 2=Frequent, 3=Always

17. Dryness, Grittiness *

Mark only one oval.

- 0: Never
- 1: Sometimes
- 2: Frequent
- 3: Always

18. Soreness or irritation *

Mark only one oval.

- 0: Never
- 1: Sometimes
- 2: Frequent
- 3: Always

19. Burning or watering *

Mark only one oval.

- 0: Never
- 1: Sometimes
- 2: Frequent
- 3: Always

20. Eye fatigue/tiredness *

Mark only one oval.

- 0: Never
- 1: Sometimes
- 2: Frequent
- 3: Always

Chose the severity of your symptoms on a scale of 0-3
0= Unnoticeable, 1=Uncomfortable, 2=Irritating, 3=Unbearable

21. Dryness, grittiness *

Mark only one oval.

- 0: Unnoticeable
- 1: Uncomfortable
- 2: Irritating
- 3: Unbearable

22. Soreness or irritation *

Mark only one oval.

- 0: Unnoticeable
- 1: Uncomfortable
- 2: Irritating
- 3: Unbearable

23. Burning and watering *

Mark only one oval.

- 0: Unnoticeable
- 1: Uncomfortable
- 2: Irritating
- 3: Unbearable

24. Eye fatigue/tiredness *

Mark only one oval.

- 0: Unnoticeable
- 1: Uncomfortable
- 2: Irritating
- 3: Unbearable

Thank you for participating in this survey. Your feedback is important!

Increased screen time use for long durations of time may increase the risk of myopia and dry eye disease. If you found yourself answering many questions with frequent, always or 2's and 3's, it is important to remember to take breaks often when using your electronic devices. Seeking medical attention may be beneficial if you feel that you have many of these symptoms or your eyesight has declined.

2023 - 2024 Junior Science & Humanities Symposium

Statement of Outside Assistance

JSHS
JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM

Students submitting their research paper to the Regional and National symposium must complete this form in full and submit with the final research paper.
Please type "N/A" in any field that is "not applicable" to your research.

Projects conducted without proper supervision will be disqualified from both regional and National competition. Further guidelines may be found at http://www.jshs.org & in the Core of Rules of Competition.

Student Participant to Complete:

Name: Jillian Meyers

Title of Paper: Relationship Between Dry Eye Disease and Myopia with the Increased Use

School: Monroe Woodbury High School

Teacher or Mentor Name: Christopher Taylor

Regional Symposium: New York-Upstate

1. **Please explain your role in the development of the project idea.**
   The project was independently designed. I developed the research question and plan independently through reading journal articles.

2. **What steps led you to formulate your research question?**
   – or – What steps led you to develop the design for your project?
   The use of digital devices increased dramatically during and after the COVID-19 Pandemic. Children began to use their devices for both school and extracurricular purposes. I noticed my personal eye sight decline after having 20/20 vision my entire life. I became curious if the increase screen time had a correlation to the decrease in eye health. I decided to further investigate the topic myself, and focused on a specific disease and condition.

3. **Where did you conduct the major part of your work? If an institutional setting, list the name.**
(e.g., home, school, or other institutional setting such as university lab, medical center, etc.)
The majority of my research was conducted at home and in school.

4. **Describe the assistance that you received throughout the project.**
My school instructors, Mrs. Flanagan and Mrs. Puopolo, guided me through my research. My mentors, Dr. Taylor and Dr. Sibia, answered my questions and reviewed my survey.

5. **If you conducted your research in an institutional setting (i.e., university lab, medical center, etc.), describe your role on the team <u>AND</u> what role each person played in the research investigation?**
N/A

6. **Describe what parts of the research you did on your own and what parts where you received help.** *(e.g., literature search, hypothesis, experimental design, use of special equipment, gathering data, evaluation of data, statistical analysis, conclusions, and preparation of written report (abstract and/or paper))*

   The literature search, hypothesis development, experiment design, analysis, and research paper were all completed independently with minimal assistance from my teachers. The survey was sent out through school administration. The gathering and evaluation of the data, statistical analysis, and conclusion were completed independently.

7. **Was any data set from an outside source (literature, handbooks, publicly available or privately shared tables, etc.) used in the research? If so, what data set(s) was used and from where was it sourced? What was its purpose in this research?**

   N/A

8. **Was the data set sourced outside this research the only way to obtain the data required for the research? Please explain.**

   N/A

9. **Is this research a continuation of an investigation that was previously submitted to a regional JSHS? If so, describe how you have expanded your investigation.**

   N/A

10. **If this is a continuation project, please submit your previously submitted abstract here (copy/paste).**

11. **Did you utilize any form of AI in your research or paper? If so, explain what tools were used AND for what purpose.**

No form of AI was utilized in my research or paper.

12. **Is there an IRB determination on file for this research? (Yes/No)**

Yes

13. **Provide the IRB determination details including IRB number, name, institution, and dates.**

Local School Approval.

14. **Provide full details about the processes and procedures utilized for your research, including usage & disposal of materials.**

The procedure utilized for my research was a self administered google forms survey.
The participants needed access to a digital device to complete the questionnaire.
They were emailed a link and directions to complete the survey.

Teacher and/or Supervising Mentor to Complete (or Parent if no teacher/mentor involvement):

Comments by teacher and/or supervising mentor on the students' individual contributions to the research investigation or engineering/computer science project. *If no Teacher or Mentor/Scientist was involved the Parent must complete this section describing their role in the research.*

Jillian made 100% of the contributions to this research investigation. She developed the research plan under the guidance of her mentor, created the questionnaire, and distributed the survey. She later analyzed the results on her own as well.

Statement by the teacher and/or supervising mentor acknowledging that the student conducted the research in accordance with proper procedures and protocols for the conduct of animal research or human research.

Research was conducted in a professional manner by the student.

The Student, Teacher and/or Supervising Mentor must sign below. ***If you did the work without a teacher or supervising scientist, you will need a signature from your parent and a brief description of their role in the research.***

11/15/2023	Jillian Meyers	Monroe Woodbury HS
Date	Signature of **Student** (required)	**Student's** High School
11/15/23	Jessica Pappolo	Monroe Woodbury HS
Date	Signature of **Teacher**	**Teacher's** High School
11/29/23	DSSibia	Sirtaz S. Sibia, DO
Date	Signature of **Supervising Mentor**	Name of **Supervising Mentor**
	Ophthalmologist	Sibia Eye Institute
	Title of **Supervising Mentor**	Institution of **Supervising Mentor**
Date	Signature of **Parent** (required if no Teacher or Supervising Mentor was involved in the research.)	Name and Phone Number of **Parent**