CORRELATION BETWEEN DRY EYE AND SCREEN TIME IN CHILDREN

by

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May 8th, 2019

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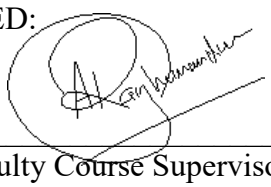

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CORRELATION BETWEEN DRY EYE AND SCREEN TIME IN CHILDREN

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ABSTRACT

Background: Use of computers and other electronic devices has been shown to cause dry eye in adults[1,2]. Little research, however, has been done to determine if this is also occurring in children who use electronic devices. The main goal of this study was to determine if there is a correlation between screen time and dry eye symptoms in children. Additionally, our study sought to determine the average amount of screen time of the pediatric population in the area served by the University Eye Clinic at the Michigan College of Optometry. *Methods:* A survey was distributed to the parents of pediatric patients at the University Eye Clinic. The survey asked several questions about their children's use of electronic devices and complaints of dry eye symptoms. The dry eye portion of this study was adapted from the Standardized Patient Evaluation of Eye Dryness (SPEED) Questionnaire. Student clinicians also indicated on the survey form if and what signs of dry eye are observable in the patient. *Results:* Three of the 39 enrolled subjects reported symptomatic dryness based on our adapted SPEED Questionnaire. The average amount of screen time per week was 39.03 hours, and 31 subjects reported some type of device use at school. *Conclusions:* Children show ocular signs associated with dry eye but subjective measures are of limited use. The current amount of digital device use is likely higher than that recommended by the American Academy of Pediatrics for overall pediatric health and development.

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I would like to thank my faculty advisor, Dr. Paula McDowell, for her assistance and guidance in this research project. I also would like to thank the student clinicians for assisting in data collection for this project.

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CHAPTER 1

INTRODUCTION

Dry eye syndrome is a complex condition with multiple mechanisms and associated symptoms[3]. Treatment methods also vary significantly, from artificial tear drops and punctal plugs to intranasal stimulators[4] and oral doxycycline. The prevalence of dry eye syndrome in adult populations has been studied frequently and has been reported as low as 5.7%[5] and as high as 54.3%[3,6], depending on the patient population and diagnostic criteria. Several factors have been found to contribute to dry eye syndrome including outdoor work, air conditioning, systemic health conditions, and tobacco use[3]. Computer vision syndrome, a condition caused by prolonged use of computers and other electronic devices, has also been shown to cause dry eye in adults[1]. Symptoms of computer vision syndrome include irritation, dryness, watering, blurred vision and eye fatigue[1,7]. One suggested mechanism for dry eye syndrome associated with computer use is that decreased blink rate while using electronic devices allows the tear film to evaporate more significantly[1,8]. Children use electronic devices at higher rates than they have in the past[9], but reported use varies greatly based on the location and age of children[10, 11]. Research has been limited to determine if dry eye syndrome is also occurring in children who use electronic devices. One study done in Korea found that increased mobile phone use was a significant risk factor to dry eye disease[11]. A study

done in Hong Kong found that the other common symptoms of computer vision syndrome, like neck and back pain, have been found in children[12]. Additionally, increased cognitive demand has also been associated with decreased blink rate[13]. Since schools are using electronic devices more frequently, the combination of electronic device use and the increased cognitive demand of school may also contribute to dry eye. The main goal of this study was to determine if there is a correlation between screen time and dry eye symptoms in children. Additionally, our study sought to determine the average amount of screen time of the pediatric population in the area served by the University Eye Clinic at the Michigan College of Optometry.

CHAPTER 2

METHODS

This study was performed among the pediatric patient population of the Michigan College of Optometry in Big Rapids, Michigan from May 2018 through December 2018. Our selection criteria included any children younger than 18 years old. Parental consent and, when appropriate, patient assent was obtained for each patient. Our goal sample size was 100 patients and we enrolled 39 patients (21 males, 18 females). A questionnaire was given to the parents regarding their child's dry eye symptoms and electronic device use. The dry eye portion was adapted from the Standard Patient Evaluation of Eye Dryness (SPEED) Questionnaire. A significant score for the SPEED Questionnaire is a 19 or higher[7]. The electronic device use portion of the survey asked for quantity information on use of various electronic devices as well as information on use of electronic device uses at school. Electronic device categories included were television, computer, cellphone, tablet, video games, and other. The American Academy of Pediatrics (AAP) recommends no electronic device use other than video-chatting in children younger than 18 months, a maximum of one hour per day for children two to five years of age, and consistent time limits on children 6 years and older that emphasizes the importance of sleep, physical activity, and other healthy behaviors[9,14]. Based on this recommendation, we considered any electronic device use significant for ages 0-18 months, more than 1 hour for children ages 2-5 years, and more than 3 hours per day on

weekends or weekdays for all older children. Student clinicians also evaluated tear break up time (TBUT) and blink rate in 30 seconds and noted any other signs of dryness noted during the patient's exam. TBUT is a generally accepted sign of dry eye syndrome and was evaluated using Fluorescein Sodium and Benoxinate Hydrochloride Ophthalmic Solution, USP 0.25%/0.4% eye drops. TBUT was considered significantly low if it was five seconds or less. Blink rate was measured over 30 seconds instead of the standard one minute, due to the increased difficulty with working with some patients in this population. Blink rate was considered significantly low if it was three or less times in 30 seconds. Other signs of dryness or other ocular surface diseases were noted by student clinicians and the overseeing doctor, and was determined to be significant on a case-by-case basis by the investigators of this study.

CHAPTER 3

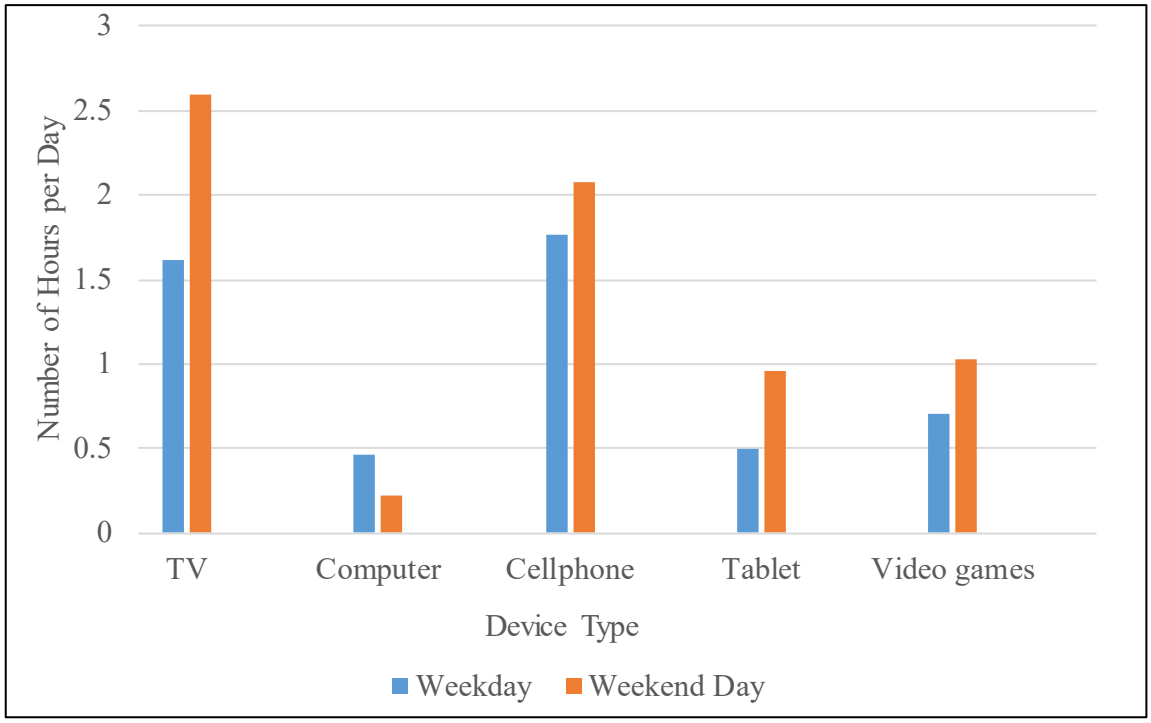
RESULTS

A total of 39 patients were enrolled in this study, 21 males and 18 females. The average age of the subjects was 10.81 ± 4.24 years (10.88 for males, 10.72 for females) with an age range of 3 to 17 years (3 to 17 for males, 4 to 17 for females). While the majority of surveys were filled out completely and correctly, some were not filled out or were filled out incorrectly in sections. Those answers were only included in the results where the intention of the parents or student clinicians were clear and were not included otherwise.

The average SPEED Questionnaire score was 4.58 ± 5.93. Three patients had statistically significant SPEED Questionnaire scores of 19 or higher (two females with scores of 20 and 24, one male with a score of 20). The average age of patients with statistically significant SPEED Questionnaire scores was 9.00 ± 2.16 years.

Several electronic device types were reported to be used on weekdays, weekends, and at school, as shown in Chart 1 on page 6. The average amount of electronic device use on weekdays was 5.06 ± 0.57 hours. The device with highest reported average amount of use on a weekday was the cellphone at 1.77 hours of use per weekday. The average amount of electronic device use on weekend days was 6.88 ± 0.85 hours. The device with highest reported average amount of use on a weekend day was the television

<u>Chart 1</u>: Average Electronic device usage in Hours per day



at 2.59 hours of use per weekend day. The average week total was calculated based on the average use on a weekday and a weekend day. The average total of hours of use per week was 39.03. The most commonly used device on a weekday was the television with 32 subjects reporting weekday use. The most commonly used device on a weekend was the television with 30 subjects reporting use. Five device categories were reported to be used in school to some degree: television, computer, cellphone, tablet, and video games. The most frequently reported item used was the computer, with 26 subjects reporting some computer use at school.

The total number of users with significantly high electronic device use was 27 (15 males, 12 females), based on the recommendations of the AAP. While we did not have any children in 18 months of age or younger, we had six subjects in the 2-5 years of age category. All of our subjects in that category reported a significantly higher amount of

use than the recommendation, with an average of 3.40 ±2.06 hours on weekdays and 6.40 ± 5.24 hours on weekend days. We had a total of 33 subjects in the older child category, 21 of which reported significant electronic device use. These subjects in this category also tended to report significantly high amounts of device use than recommended on average, with an average of 5.17 ± 5.18 hours on weekdays and 6.86 ± 6.60 hours on weekend days. Overall, subjects who had significant high hours of electronic device use tended to be older, with an average age of 12.19 ± 4.59 years, but less than one standard deviation higher than the overall average age.

The TBUT was separated in three categories as shown in Table 1 on page 8: normal, borderline, and significant. Five subjects showed a significant TBUT, defined as five seconds or less. TBUT was unattainable on eight patients due to their age or cooperation and was not recorded for two patients. Blink rate was also divided into three categories as shown in Table 2 on page 8: normal, borderline, and significant. Six subjects had a significantly low blink rate, defined as three times or less in 30 seconds. Blink rate was not recorded on four patients. The average blink rate was 6.69 ± 4.01 blinks per 30 seconds. Various other signs of dry eye syndrome were recorded as shown in Table 3 on page 8 and five patients had other significant signs of dry eye syndrome. In total, between TBUT, blink rate, and other signs, fourteen subjects had objectively significant signs of dry eye syndrome (6 males, 8 females). Subjects with objectively significant signs of dry eye syndrome tended to be older, with an average age of 14.27 ± 3.88 years.

Of the subjects who were symptomatic, two subjects also reported high use of electronic devices and one of those two subjects also had objectively significant signs of dry eye syndrome. The other symptomatic patient did not have objectively significant signs of dry eye syndrome and did not report high use of electronic devices. The average SPEED Questionnaire score of subjects who reported high electronic device use was 4.31. The average SPEED Questionnaire score of subjects with objectively significant

Table 1: Categorized TBUT

Classification	Number of Subjects
Normal – 10 seconds or more	13
Borderline – less than 10 but more than 5 seconds	11
Significant – 5 seconds or less	5
Unable	8
Not recorded	2

Table 2: Categorized blink rate

Classification	Number of Subjects
Normal – 8 times or more	10
Borderline – less than 8 but more than 3 times	19
Significant – 3 times or less	6
Not recorded	4

Table 3: Other reported signs of dry eye syndrome

Signs	Number of Subjects
Superficial punctate keratopathy	6
Capped Meibomian glands	5
Lagophthalmos	1
Papillae	5
Lash debris	1
Abnormal tear quality	3
Conjunctival staining	1
Other ocular conditions (recurrent redness, previous diagnosis of dry eye syndrome)	2

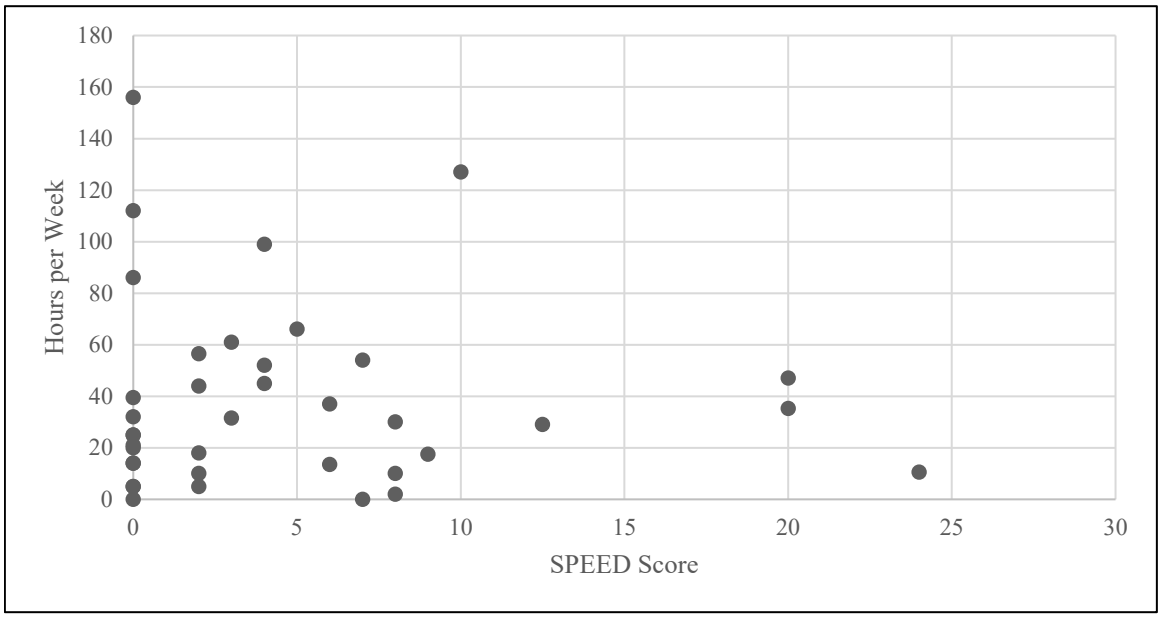
signs of dry eye syndrome was 4.57. Neither of these are significant according to the SPEED survey or in comparison to the overall average SPEED Questionnaire score (4.58 ± 5.93). Of the subjects who reported high use of electronic devices, 9 subjects also had objectively significant signs of dry eye syndrome. The average TBUT in subjects who reported high electronic device use was 6.59 seconds, which is a borderline value. The average TBUT in subjects who had a significant SPEED Questionnaire score was use was 9.83 seconds, which is also a borderline value. The average blink rate in subjects who reported high electronic device use was 9.09 blinks in 30 seconds, which is in the normal value category. The average blink rate in subjects who had a significant SPEED Questionnaire score was 6.67 blinks in 30 seconds, which is a value in the borderline category.

CHAPTER 4

DISCUSSION

Our primary goal was to determine if there was a correlation between screen time and dry eye symptoms in children. Very few subjects reported significant symptoms in the adapted SPEED Questionnaire. However, there were objectively significant signs of dry eye syndrome in more than a third of patients. When evaluating the overall trends, there was not a correlation between screen time and symptoms or dry eye in children, as shown in Graph 1. This may be due to two reasons. First, it is possible that the amount and severity of dry eye symptoms was underreported because the parents were completing the survey based on their child's complaints. The children may not be

<u>Graph 1</u>: Symptom score versus total weekly hours of device use



reporting all their symptoms to parents either because they are afraid to lose out on something they enjoy, like electronic device use, or because they do not realize that the symptoms they are experiencing are abnormal. Unfortunately, due to the population being studied, it may be particularly difficult to get subjective findings of dry eye experiences. Second, it is possible that the signs of dryness that we marked as clinically significant may not be clinically significant due to lack of established normative values of dry eye syndrome in children. Further study into the tear film quality and stability in children should be done to determine if this is significantly different than that of adults.

Our secondary goal for this study was to determine the average amount of screen time of the pediatric population in the area served by the University Eye Center at the Michigan College of Optometry. The average weekly use, 39.03 hours, was significantly higher than that recommended by the AAP for young children. While there are no specific numerical values listed for teens or adolescents, this number is just one hour shy of what would be a full time job for a working adult. This was comparable to the urban value found by Moon *et al*[11]. This is significant as the area surrounding the University Eye Center at the Michigan College of Optometry is typically considered a relatively rural area. Rural areas typically have less electronic device usage, suggesting that these numbers may even be lower than the general population[11].

The American Academy of Pediatrics (AAP) warns against significant electronic device usage, particularly unsupervised usage[9]. The first reason given by the AAP to caution parents is the importance of an active life to prevent obesity and other conditions that are associated with sedentary activity. The second is to ensure that children have minimal exposure to alcohol, sex, and tobacco usage on social media, minimizing the

effects of cyberbullying, and maximizing privacy and safety. The AAP recognizes the benefits of increased socialization through social media and video-chatting but recommends that first priorities should be given to ensuring children have adequate sleep and physical activity. The American Academy of Pediatrics recommends no electronic device use other than video-chatting in children younger than 18 months, a maximum of one hour per day for children two to five years of age, and consistent time limits on children 6 years and older that emphasizes the importance of sleep, physical activity, and other healthy behaviors[9,14]. The majority of our subjects failed to meet these guidelines.

One limitation of our study was the small study size, which limited the significance of the findings of the study. Finally, while there were several signs of dry eye syndrome in the pediatric population, correlation does not necessarily equate to cause in this case. There were several children who may have had ocular allergies, or pre-existing dry eye separate from their device use. Some or all of this study should be performed again on a larger population to determine if these findings can be applied to larger populations.

CHAPTER 5

CONCLUSION

Dry eye syndrome due to computer use may be occurring in children in the same way as it is happening in adults but subjective measurements may be less useful in children. Subjective measures are of limited use and do not always correlate with objective signs of dryness. Some children, like those in the area surrounding the University Eye Center at the Michigan College of Optometry, are using electronic devices in a week almost as much as adults spend at a full time job. This is more than the recommended limit of electronic device use put forward by the AAP to prevent overall poor health and development. More research is needed on this topic to determine how children are using electronic devices, and how that use is contributing to their ocular health.

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APPENDIX A

IRB APPROVAL FORM

Date: May 18, 2018

To: Paula McDowell

From: Gregory Wellman, R.Ph, Ph.D, IRB Chair

Re: IRB Application *IRB-FY17-18-164 Computer Vision Syndrome in Kids*

The Ferris State University Institutional Review Board (IRB) has reviewed your application for using human subjects in the study, *Computer Vision Syndrome in Kids(IRB-FY17-18-164)* and approved this project under Federal Regulations Exempt Category 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Approval has an expiration date of three years from the date of this letter. **As such, you may collect data according to the procedures outlined in your application until May 18, 2021**. Should additional time be needed to conduct your approved study, a request for extension must be submitted to the IRB a month prior to its expiration.

Your protocol has been assigned project number IRB-FY17-18-164. Approval mandates that

you follow all University policy and procedures, in addition to applicable governmental regulations. Approval applies only to the activities described in the protocol submission; should revisions need to be made, all materials must be reviewed and approved by the IRB prior to initiation. In addition, the IRB must be made aware of any serious and unexpected and/or unanticipated adverse events as well as complaints and non-compliance issues.

Understand that informed consent is a process beginning with a description of the study and participant rights, with the assurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document and investigators maintain consent records for a minimum of three years.

As mandated by Title 45 Code of Federal Regulations, Part 46 (45 CFR 46) the IRB requires submission of annual reviews during the life of the research project and a Final Report Form upon study completion. Thank you for your compliance with these guidelines and best wishes for a successful research endeavor.

Regards,

Gregory Wellman, R.Ph, Ph.D, IRB Chair

Ferris State University Institutional Review Board

Office of Research and Sponsored Programs

APPENDIX B

SURVEY FORM

Study: Correlation Between Screen Time and Dry Eye in Children **Number:_____**

Parents: Please fill out the following questions about your child

Current age of Child _____ Gender: ☐Male ☐Female

Please indicate any of the following eye symptoms that your child has experienced. For all symptoms that your child has experienced, please also indicate when those symptoms have occurred.*

*Adapted from the Standardized Patient Evaluation of Eye Dryness (SPEED™) Questionnaire	No	If YES: When		
		Today	Within last 72 hrs	Within last 3 months
Dryness, Grittiness, or Scratchiness				
Soreness or Irritation				
Burning or Watering				
Eye Fatigue				

Please indicate the frequency that your child has experienced the following symptoms.

	Never	Sometimes	Often	Constant
Dryness, Grittiness, or Scratchiness				
Soreness or Irritation				
Burning or Watering				
Eye Fatigue				

Please indicate the severity of the symptoms your child has experienced.

	None	Tolerable	Uncomfortable	Bothersome	Intolerable	Unknown
Dryness, grittiness, or Scratchiness						
Soreness or Irritation						
Burning or Watering						
Eye Fatigue						

The next several questions are related to screen time. Please list the number of hours your child uses each of the devices on an average weekday or weekend day. Please also indicate if any of these devices are used by your child while at school.

	Hours on a weekday	Hours on a weekend day	Use at school
Television			
Computer			
Cellphone			
Tablet			
Video games			
Other (please describe)			

For Student Clinician: Please fill out the following information:

TBUT: _____ **Blink rate: _____**

Other Signs of Dry Eye: _____