A RETROSPECTIVE STUDY ON THE OUTCOME OF REFRACTIVE ERROR IN PREMATURELY BORN ADULTS

by

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ABSTRACT

Purpose: This study was performed to determine if premature birth produces an explicit refractive error in adults. The study has correlated this in retrospection. *Methods*: Patients between the ages of twenty and sixty-five were asked if they were born at least three weeks premature. If this was proven, a comprehensive eye exam was performed on the patient to assess their refractive error. The twenty-four (forty-eight eyes) premature patients' spherical equivalent was then compared to the one hundred forty-six (two hundred ninety-two eyes) patients' spherical equivalent that were full term. *Hypothesis:* Our study proved that adults who were born premature had a spherical equivalence of myopia initiated by their prematurity. *Results:* Of the twenty-four patients (forty-eight eyes) who were proven to be premature, thirty-one eyes were myopic (greater than or equal to -0.75 diopters (D)), eight eyes were hyperopic (greater than or equal to +1.00D), and nine eyes were emmetropic (between -0.50 and +0.75D). Of the one hundred forty-six patients (two hundred ninety-two eyes) who were full term, one hundred twenty-three eyes were myopic (greater than or equal to -0.75D), ninety-two eyes were hyperopic (greater than or equal to +1.00D), and seventy-seven eyes were emmetropic (between -0.50 and +0.75D). *Conclusion:* Our results found that adults, who were born premature by at least three weeks, were more likely to have a myopic adult refractive error than patients who were born full term.

Key words: premature birth, refractive error, myopia

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Introduction

There has been little research on whether prematurity in infants has any effect on adult stabilized refractive error. However, it has been shown that premature birth signals an increased risk for abnormal refractive development.[1,2] There have been numerous studies on refractive error following premature patients as they progress from birth to thirty-six months of age.[3] It is believed that the outcome of their refractive error as an adult will considerably add to the previous knowledge we have in this area. This information may determine what effect refractive error has on prematurely born adults. With this information, it will allow the parents of premature infants to be educated on the correlation between prematurity and refractive error. This may also change the standard of eye care for premature infants, initiating vision screenings sooner, and helping the perspective students in the classroom setting.

Currently, the only studies done on refractive error versus prematurity involve how the refractive error in premature infants changes as they develop, until they reach anywhere from approximately six months to five years of age. Most clinical research shows a relationship between increased myopia in premature infants than in full term infants.[1,2] The current research will add to our data because there are many factors to consider, such as environmental, developmental, and disease factors that were not considered in our study. It was noted in previous research of preterm infants that there was a significant correlation between corneal curvature growth and refractive status resulting in increased myopia when compared to full term infants. It appears that a variation in the normal growth of the eye is caused by the prematurity thus leading to the refractive error. This disruption in growth results in abnormalities to parts of the eye which affect the re-

fractive development. These structures might include corneal curvature, axial length, lens thickness, and anterior chamber depth.[4]

Methods

Our testing population consisted of twenty-four premature (by at least three weeks) and one hundred forty-six full term (used as the control group) subjects. This project was approved by the Human Subject Review Committee of Ferris State University. Permission was obtained from each subject who participated in the study prior to testing (Appendix A). All subjects signed a consent form, and were guaranteed that their anonymity would be protected. There were no predetermined selection criteria involved, as the time allocated for patient testing was a three month period chosen at random.

All one hundred seventy patients (twenty-four premature and one hundred forty-six full term) received a comprehensive eye exam. The comprehensive refractive examination data was compared to the control group who were born full term. Analyses of the data using statistics, focused on how many patients are myopic, hyperopic, or emmetropic calculated by spherical equivalence. The spherical equivalent equation that was used equaled sphere power plus one half of cylinder power. Myopia was defined as greater than -0.75D, hyperopia greater than +1.00D, and emmetropia between -0.50 and +0.75D). Astigmatism was not assessed.

Once the refractive errors were categorized, we analyzed the data by comparing the percentage of premature patients that were myopic to the percentage of full term patients who were myopic (64.5% premature divided by 42.1% full term equals 1.53 times more of a chance of being myopic if born premature). To determine if this amount was

statistically significant we used the Chi-square method and the following formulas and calculations:

Degrees of Freedom: (number of groups of groups analyzed-1) = (3-1) = 2

Observed: number of premature patients who had the refractive error analyzed

Expected: percent of total patients who were myopic times the number of total premature patients

Chi-square Formula[7] $= \frac{(\text{Observed-Excepted})^2}{\text{Expected}}$

Hypothesis

Before performing the study, we believed that a certain type of refractive error would be found in adults who were born premature, compared to those who were full term. We proposed that the outcome would demonstrate myopia in a greater percentage of the participants in this study. This hypothesis was due to our proposed theory that premature infants are born with significant myopia, and this uncorrected refractive error would not be reduced by emmetropization. A previous research study has shown when infants are born they are slightly myopic, and become more hyperopic as they age.[2] If a baby was born premature, it is then assumed they may be even more myopic than a full term baby. It has been shown in studies of animals that if there was sufficient blur between birth and eighteen months (when emmetropization occurs) then they would become even more myopic.[5] In a study on chicks "refractive error starts off at plano to +10.00D at age 2 weeks, but is +2.00D in nearly all chicks by age 8 weeks. When their eyes were covered with translucent occluder lenses, however, the chicks developed an

average –12.00D of myopia within 1-2 months."[6] These lenses can be thought of as stimulating myopia. If premature infants had significant myopia when they were born, they may have developed even more myopia due to this blur. Emmetropization itself usually reduces the hyperopia found in young children. Reducing the plus power in myopic infants would increase the amount of myopia, thus adding to our theory.

Results

Each of the patient's refractive error was put into one of three categories (myopia, hyperopia, emmetropia). Of the twenty-four patients (forty-eight eyes) who were proven to be premature, thirty-one eyes were myopic (greater than or equal to -0.75D), eight eyes were hyperopic (greater than or equal to +1.00D), and nine eyes were emmetropic (between -0.50 and +0.75D). Of the one hundred forty-six patients (two hundred ninety-two eyes) who were full term, one hundred twenty-three eyes were myopic (greater than or equal to -0.75D), ninety-two eyes were hyperopic (greater than or equal to +1.00D), and seventy-seven eyes were emmetropic (between -0.50 and +0.75D). Figure 1 and tables 1-2 represent the refractive error breakdown.

Figure 1: Premature versus Full Term Patient's Refractive Error

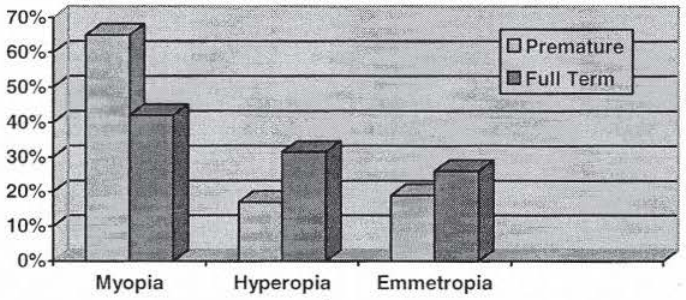

Table 1: Premature Patient's Refractive Error

	Premature Patients		
Eye/Eye total	Myopia (≥ -0.75D) 31/48	Hyperopia (≥ +1.00D) 8/48	Emmetropia (-0.50≥X≤+0.75D) 9/48

Table 2: Full Term Patient's Refractive Error

	Full Term Patients		
Eye/Eye total	Myopia (≥ -0.75D) 123/292	Hyperopia (≥ +1.00D) 92/292	Emmetropia (-0.50≥X≤+0.75D) 77/292

After collecting our data, we did a statistical analysis using the Chi-square method.[7] The Chi-square method allowed us to determine if our results were statistically significant compared to the probability of chance. We analyzed each of the refractive error groups with the following results.

Chi-square Formula[7] = $\frac{(\text{Observed-Excepted})^2}{\text{Expected}}$

Myopia

$((31-19.8)^2)/19.8=6.34$

Probability=0.05 (statistically significant)*

Hyperopia

$((8-15.1)^2)/15.1= 3.34$

Probability=0.20 (statistically non-significant)*

Emmetropia

$((9-12.7)^2)/12.7=1.08$

Probability= 0.60 (statistically non-significant)*

*Probability and significance were calculated using Chi-square table in Appendix B

Our research and results demonstrated that a premature infant is statistically more likely to be myopic than a full term infant.

Discussion

After analysis of the data, we concluded that premature patients are one and one half times more likely to have an adult myopic refractive error compared to adults who were full term. There results, if proven further with a prospective study, as well as additional data, could help us prevent or reduce myopia from developing long-term in adults who were premature infants. This data would allow the pediatrician the knowledge to tell the parents of premature infants to have their infants' eyes checked shortly after birth. This would also allow the eye care professionals to understand the correlation between prematurity and refractive error; therefore, allowing them to correct the significant myopia, minimizing its occurrence.

A prospective study should also be done to reinforce the conclusion of this study. Because most sources of error due to confounding and bias are more common in retrospective studies than in prospective studies, retrospective investigations are often criticized, and should therefore be repeated by a prospective study.[8] An optometrist could follow one hundred premature children from birth to age twenty to find out how their refractive error progresses each year. This will provide more conclusive evidence than a retrospective study, as well as eliminating any potential bias.

In hindsight, we also feel the refractive error in our study should have been broken down into simple myopic astigmatism, simple hyperopic astigmatism, compound myopic astigmatism, compound hyperopic astigmatism, and mixed astigmatism. In addi-

tion, some of our data could be slightly misrepresented because we only used the patient's spherical equivalent. We also believe the results would be more conclusive if we had obtained the patient's keratometry readings, as well as their axial length. This would have allowed us to know if the patient's refractive error was mostly due to their corneal curvature or axial length. If the results show that prematurity leads to refractive myopia as an adult, as previous research proposes, we could provide much more information earlier on to prevent or reduce their adult refractive error.

Conclusion

This study was designed to determine the effect prematurity has any impact on future adult refractive error. The correlation would then allow us to educate the parents on the possible refractive error and the importance of annual and early eye exam for children. Our research revealed that premature infants are one and a half times more likely to have myopia than a patient who was born full term. Based on our study, parents should have an eye care professional monitor and correct their child's refractive error. Additional prospective research should be done to reinforce our data and provide more information; therefore, educating eye care professionals and parents on the nature of this process.

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APPENDIX A

PERMISSION SLIP

Dear Patient:

We are senior interns at the Michigan College of Optometry at Ferris State University, and are conducting a research study. We are asking for your participation in the study. The purpose of this research is to determine if there is a correlation between prematurity and stabilized adult refractive error.

This study involves two questions: were you born prematurely and if so by how many weeks. Your refractive error found in the examination will also be recorded. Your privacy will be protected because names will not be used in the final report. No diagnoses, recommendations or treatments will be assigned to any individual participating.

We hope this research will benefit optometry by allowing us to predict possible future refractive error in premature infant patients, which will allow us to catch vision related problems sooner.

If you are willing to participate in this study, please sign the form below. Any questions about this study may be directed to Dr. Michael Cron at (231) 591-2171.

Thank you for your time and consideration.

Sincerely,

Kristine M. Van Laan	Melissa E. Blum	Michael T. Cron, O.D.
Optometry Intern	Optometry Intern	Faculty Advisor

I am willing to participate in the vision research study.

_____ _____

Patient Signature Patient Name (Print)

Concerns about the conduct of this research may be directed to the Chair of FSU's Human Subjects Review Committee, Dr. Connie Meinholdt, at (231) 591-2759.

APPENDIX B

CHI-SQUARE DISTRIBUTION TABLE

Chi-Square Distribution[7]

Degrees of Freedom *(df)*	**Probability** (p)										
	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59
	Non-significant								Significant		