The Development of Myopia in Late Starting Readers in the Homeschool Population of the United States

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Introduction

Classically, the etiology of myopia has been the subject of much research. Many factors, such as genetic predisposition and environmental conditions can affect the level of myopia found in specific populations. The development of myopia has been linked with reading and nearpoint stress. McBrien and Barnes (1) have noted that among the many aspects of myopia control, autonomic control of accommodation implies the widest range of potential mechanisms for myopia onset and progression.

The nearwork theory of myopia is supported by evidence including high rates of myopia in cultural groups with high literacy (2,3), an association of increased myopia with higher educational level (4,5), and increased myopia with higher amount of time spent reading and performing nearwork (6). Reports also link increased levels of myopia with the introduction of schools into previously illiterate populations (7).

Accommodation accompanies nearpoint work, especially as noticed in the school setting. Young et al. (7) documented refractive shifts towards myopia in the Alaskan Eskimo population when mandatory educational standards were introduced to their society. This dramatically increased nearpoint tasks to an isolated group that had previously been unschooled. Virtually no myopia existed among unschooled Eskimo parents and grandparents, while more than half of the schoolchildren were myopic.

Dr. Raymond S. Moore (8) cited that a shift toward myopia was demonstrated through the records of Henry Hilgartner, a Texas ophthalmologist. Dr. Hilgartner and his father, also an eye specialist, kept careful records over fifty years for all the 8 to 12 year old children they examined. As the Texas law changed, requiring school entrance age to drop from 8 to 7 (1907-08) and then to age 6 (1930-31), their records show that the ratio of hyperopes to myopes changed from 8:1 (early 1900's), towards 2:1 (1930), and finally became 1:1 (1940) in the patient population they saw. These changes were linked by Dr. Hilgartner with nearwork causing excessive accommodation for young schoolchildren in the school setting.

Young et al. (9) found a low positive correlation between greater time spent reading and myopia at ages 6 to 12, and a high correlation at ages 12 to 17. Sato (10) proposes that the mechanism by which nearwork causes myopia is through accommodation, whereby the ciliary muscle contracts during reading, leading to an organic change in, and increased refractive power of, the crystalline lens.

Other studies propose that the axial length of the eye is the main contributing factor to the level of myopia found, and that excessive near work causes greater axial length. Elongation of the ocular axis, relative thinning of the crystalline lens and flattening of the cornea occur with normal growth, so that most children are emmetropic at the age of 8 to 10 years. Francois and Goes (11) divided the normal development of the axial length into a rapid post-natal phase (age 0-1), a slow infantile phase (age 1-7), and an even slower juvenile phase (age 7-14 years). From Japanese population studies by Hosaka (12), it is found that the refractive condition in each person is mainly determined by axial length. In Japan, the frequency of myopia is higher than 55% in the student population.

Numerous new cases of myopia appear between the ages of 7 and 13, at least among populations of schoolchildren in all ethnic groups. However, inconsistencies in studies equating intelligence with myopia have added to the controversy concerning whether myopes read more, or whether reading produces more myopes. According to the National Research Council's (13) report on myopia, "nonschool populations have not been studied sufficiently to determine whether onset of myopia among children is a general phenomenon or primarily affects only schoolchildren." With this in mind, a population within the United States was sought that has chosen to wait to begin formal education until a later age than the average American child.

This study was a retrospective study consisting of individuals whose formal reading education started after the age of eight, as compared with the average schoolchild, whose formal education began at age 5 or 6. Specific refractive information for each member of the sample population was gathered from that individual's doctor's records. The prevalence of myopia of the sample population was to be compared with myopia prevalence figures of schoolchildren that had been collected by Hirsch (14), Young et al. (15), and Langer (16).

Based on the studies previously cited (Young et al., Sato, Hilgartner), we propose that accommodative stress adds to the developmental factors of myopia (which include genetic factors, and environmental conditions such as psychological stress, nutrition, and prematurity). We hypothesize that if intense nearwork, such as reading, can be delayed until the physiological structures of the eye have been well developed (age 8), then the prevalence and amount of myopia will be less.

Methods

In order to test our hypothesis, we contacted the homeschool population, families that chose to educate their children in the home setting, nationwide. We called homeschool editors, and sent information about our research project to organizations in each state, with the purpose that

information/ release forms (see figure 1) would be printed in homeschool newsletters and distributed at conventions, to solicit individual responses. We also asked homeschool leaders for specific names of possible candidates that we could contact directly.

Figure 1

READING & VISION RESEARCH

Two senior optometry students, affiliated with Dr. Raymond Moore's research team are researching the effects of reading on eye sight. If you or your children have delayed formal reading instruction until close to age eight or older, information about you and your vision is needed for our study.

If you are willing to participate in our study, please fill out the following form, including a separate release form for each candidate so that we may obtain the needed findings from your doctor. Hand written copies are acceptable. No individual's name will be utilized in the study, but all data will be grouped for analysis and reporting. No involvement from you will be required beyond filling in this consent form. We are not affiliated with any state or educational institution and hope our study will be able to show a benefit of homeschooling. Please mail forms to:

Marsha Brandon & Claire Heinonen
Room 401 Pennock Hall
Ferris State University
Big Rapids, MI 49307

Release Form

Name of candidate:_____
first middle last

Address:_____
street state ZIP

Sex: M F Birth Date: _____
month/day/year

Age when reading instruction began: _____
or age child began reading over an hour at a time without formal instruction if applicable: _____.

Candidate's family eye doctor, _____, has my permission to forward eye exam
doctor's name /city/state
information pertaining to the candidate named above.

Signature: _____
Parent's signature if candidate is a minor

Note: If you do not have a family eye doctor or have never had an eye exam, but would like to participate in the study, please contact Marsha and Claire at the address above. Eye examinations may be granted for select patients.

The information/release form contained two sections. First, the information section gave an introduction of two senior optometry students researching the effects of reading on eyesight. Myopia was not mentioned in the explanation. The age criterion was explained so only those who began formal reading instruction after the eighth birthday were qualified to participate. Finally, a promise of confidentiality was given, that no individual names would be used in the study, and that the data would be grouped for analysis. The release form was designed so study participants could mail the completed form to the researchers, with no further involvement required. Information requested on the release form included the name, address, and birth date of the candidate, the age when reading instruction began, or the age when the child began reading over an hour at a time without formal instruction, if applicable, and the family eye doctor's name. A signature was required so the release form could be used to request refractive information from the family eye doctor.

The Blue Book of Optometry and The Red Book Of Ophthalmology were used to obtain the addresses of the eye doctors listed on returned release forms. Each doctor received a personalized letter explaining that their patient had chosen to participate in a retrospective study pertaining to the development of myopia as it related to the age when reading instruction began. Included with the letter was a refractive status form to be filled out by the doctor from his office records and a postage paid envelope to return the completed form to the researchers. The refractive status form (see figure 2) requested refractive information from the most current eye examination, along with data collected over time at previous exams. The refractive information included, if possible, subjective refraction, manifest retinoscopy, and cycloplegic retinoscopy findings, as well as the date of the exam findings.

Figure 2

Refractive Status

Name of Patient _____State_____

Date of Birth_____Eye Doctor_____

Please write:
*Most current refractive status first. If available, write up to three different refractions to show how the status has changed with time. Please include the date data was collected.
*Retinoscopy findings if significantly different from subjective.

	Subjective Rx	Manifest Retinoscopy	Cycloplegic Retinoscopy
O.D.			
O.S.			
Rx Date:			
O.D.			
O.S.			
Rx Date:			
O.D.			
O.S.			
Rx Date:			

When refractive status forms were collected, the information was grouped into categories. A binocular mean spherical equivalent refractive error was computed for each examination with refraction. Separate groupings were made, depending on the child's sex and age at the time of the most recent refractive findings. Our intent was to compare binocular mean spherical equivalent values and to place them into separate categories; first, the prevalence of any myopia, and second, myopia of greater than 1 D. The data of the experimental group was to be compared with prevalence figures that had been published by Hirsch, Young et al. and Langer (see Table 1).

	Hirsch (1952)				Young et al. (1954)		Langer (1966)			
	Myopia of any amount		Myopia > 1 D.		Myopia > 1 D.		Myopia of any amount		Myopia > 1 D.	
Age	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
5-6	6.15	7.43	0.45	0.67	4.17	0.00	2.04	0.00	0.00	0.00
7-8	9.71	11.02	0.98	0.90	2.60	5.62	3.97	3.08	0.00	1.54
9-10	17.18	15.68	2.01	1.82	19.44	9.68	12.20	11.68	6.71	5.11
11-12	21.60	20.74	5.77	3.08	20.00	27.27	29.18	20.48	10.26	5.71
13-14	25.36	22.53	5.78	5.08	25.71	28.57	34.42	34.30	19.48	15.01

Table 1: Myopia Prevalence Among U.S. Schoolchildren in Various Populations, 1952-1966: National Research Council Committies on Vision Working Group on Myopia Prevalence and Progression, 1989.

The visual survey by Hirsch was completed in 1952 on a group of 9,552 randomly selected elementary schoolchildren from the Los Angeles area between the ages of 5 and 14 at the nearest birthday. A spherical equivalent refractive error of the right eye was recorded, as determined by manifest retinoscopy. Young et al. (9, 15) conducted a 1954 survey of 652 schoolchildren in the college town of Pullman, located in a wheat farming community in southeastern Washington. Young et al. used spherical equivalent refractions for the right eye determined by manifest retinoscopy. Langer conducted his survey of myopic prevalence in 1966 while working on his Master's thesis at Indiana University.

Each study showed an increase in the prevalence of myopia with age. The largest increase in prevalence for girls occurred between the 7-8 and 9-10 year old age levels for both the Hirsch data and the Young et al. data. For boys the largest difference occurs between the age groupings of 9-10 and 11-12 year olds. This would imply that the most common ages for myopia onset are about 9-10 years old for girls and age 11-12 years old for boys.

Limitations of Methods

According to Goss (17), valid myopia studies should be double blind in nature and a large number of subjects are required in both the experimental and control groups. There also needs to be a refractive error protocol for measurement that is followed rigidly. Variables that may affect the results must be considered and proper statistical treatment of the data is a must.

This study was a retrospective study which was not double blind in nature. In the literature search involved with this topic, it was noticed that many myopia studies are retrospective in nature, and that they seemed to show valid results since myopia manifests itself in a straightforward manner. In comparison, other ocular anomalies, such as hyperopia, can seem quite variable if specific techniques, such as cycloplegia, are not employed.

Our study used many correspondence methods including mailings, phone calls, and distributions of information/release forms in newsletters and seminars. Because of this, we had no way of knowing exactly how many subjects were contacted, or if there were other factors that influenced the number of responses received. The study required two separate responses; the first one from the participant, and the second one from the eye doctor. The refractive data was taken from many doctor's records, where variable techniques most certainly were employed, thereby minimizing the control factor one might have if strict standards were set and complied with by fewer data collectors.

The population we chose to investigate, late readers, was a difficult group to find. Beyond the complex task of finding late readers, came the added challenge of convincing them to respond to a study about eyesight. Homeschoolers that chose to delay formal reading instruction were actually a minority group within the homeschool population, and tended to be very cautious responders. Parents of the late reading population went against conventional society by educating their children at home and deciding to follow a different educational time table than traditionally accepted. Many of the parents of this group had, over time, been harassed by the law, which tried to force their children into a traditional school setting. This outside harassment had influenced homeschoolers to be cautious about giving information such as names and age of formal instruction to groups they know little about. Some hesitated to respond to our study if they felt our results might show negative conclusions pertaining to homeschooling.

The political aspect of homeschoolers became evident over the course of our study. We became aware of a variety of educational leaders with differing philosophies that served as the underlying reason they believed homeschooling was the best educational option for their proponents. Different

educational leaders had separate loyal followers, and if we were perceived as being associated with any particular leader, we ran the risk of alienating other homeschoolers of an opposing philosophy. However, by not associating with any single educational leader, we were looked upon questionably by most homeschoolers.

We limited our correspondences to those homeschool groups that required no fee to publish or distribute our information/release forms, due to the fact that we had minimal financial backing. Our forms were occasionally perceived as advertisements, so a few organizations refused to publish our study forms without a charge.

A number of late readers that responded to our study had never received an eye exam. Most of these people expressed an interest at being included in the study if we could underwrite the cost of an eye examination. Since our funding was limited, we were unable to offer this option. Future studies should consider this option seriously to be more successful in obtaining a large enough sample population, and possibly have the opportunity to begin a longitudinal study of this particular population.

Results

Data generated over a twelve month period included eleven respondents with refractive data and thirteen responses from eligible individuals who had never had an eye exam. Compiled data are listed in figures 2 and 3 separated by gender. There were eight males and three females in the refractive data group and some of these respondents listed refraction findings from more than one exam. The oldest subject was born in 1954, while the youngest was born in 1984. Formal reading instruction, or the age when the child began reading without formal instruction for more than one hour, varied in the subjects from 7.5 years to 10 years of age. The ages of subjects at the time of examination ranged from 3 years-2 months to 31 years-6months with the majority falling between the 6 to 12 year old age bracket.

The refractive findings were subjective unless otherwise noted in the table (cycloplegic retinoscopy on one patient and manifest retinoscopy on one patient). The binocular mean spherical equivalent was calculated for each reported exam and recorded onto tables 2 and 3.

Name/ Sex	D.O.B	Reading Age	Age at Exam	Rx at Exam	Binocular Mean Sphere Equivalent
JBM-m	08/10/80	8.5	5-10	+0.75	+0.75
				+0.75	
			7-6	+0.25	+0.37
				+0.50	
ACM-m	04/15/83	8	3-2	+0.75 cyclo ret	+0.75
				+0.75 cyclo ret	
			4-10	+0.25	+0.25
				+0.25	
MAP-m	06/26/84	7.5	6-0	-1.00-0.50x180	-1.25
				-1.00-0.50x180	
LBD-m	10/01/57	8	30-?	-0.50-0.50x010	-0.81
				-0.50-0.75x173	
			31.5	-0.25-0.50x175	-0.37
				pl-0.50x010	
JRJ-m	07/13/83	not yet at 8.5	6-0	+0.50-0.50x008	+0.25
				+0.50-0.50x177	
EGS-m	12/04/81	8.5	8-11	pl manifest retinoscopy	-0.06
				pl-0.25x090 manifest retinoscopy	
JFD-m	04/12/77	10	10-11	-0.50	-0.56
				-0.50-0.25x090	
			13-7	-1.25	-1.37
				-1.50	
			14-5	-2.00	-2.12
				-2.25	
JAD-m	02/25/82	10	7-2	-0.25	-0.37
				-0.50	
			8-3	pl	pl
				pl	
			9-7	pl	-0.06
				pl-0.25x165	

Table 2: Data from male readers starting instruction after age eight

Name/ Sex	D.O.B	Reading Age	Age at Exam	Rx at Exam	Binocular Mean Sphere Equivalent
LDC-f	07/27/79	8	11-3	pl-1.00x095	-0.31
				+0.25-0.75x075	
MRD-f	05/18/54	8	29-2	-0.75	-0.81
				-0.50-0.75x050	
AFW-f	08/17/80	11	8-9	+1.00	+1.12
				+1.25	
			10-7	+0.25	+0.25
				+0.25	

Table 3: Data from female readers starting instruction after age eight

The preliminary data were graphed by marking one refraction per subject using the most recent exam data, to determine general distribution. No separation for sex or age was used due to such a small number of responses (see Figure 3).

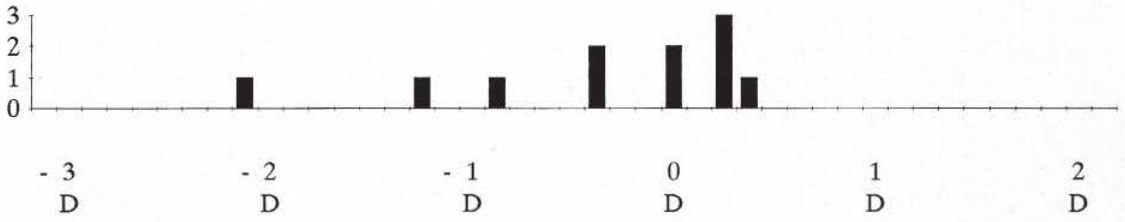

Figure 3: Number of people in dioptric categories

Discussion

Due to the lack of sufficient data, the preliminary results of this study neither prove nor disprove the hypothesis that delaying nearwork until after age eight will decrease the prevalence and amount of myopia.

Graphed results (Figure 3) appeared to follow a normal distribution curve of refractive status as described by Borish (18), but no trend could be determined as to myopic prevalence with only eleven bits of refractive information scattered across many age levels. It is recommended that the data in this paper be considered preliminary findings, and that before conclusions can be drawn, more data need to be collected from other populations of late readers such as those in adult literacy classes as well as the homeschool populations.

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