

Article ▶ Psychological Stress in Childhood and Myopia Development

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ABSTRACT

Background: Myopia is a common human vision problem and is increasing in prevalence, yet its etiology remains unclear. A role of psychological stress in the etiology of various ocular disturbances has been suggested, but virtually no research has explored a possible link between psychological stress and myopia development.

Methods: In this extension of a recent study, participants (n = 457) who were predominantly undergraduate students completed an anonymous survey assessing both their adult evaluation and retrospective childhood evaluation of their childhood stress.

Results: Myopic participants had a significantly higher score on the Stress-Fear-Abuse scale in a factor analysis than did emmetropic participants. Exploratory analyses suggested that myopes in their childhood had lower self-esteem, were more lonely, experienced more criticism about physical aspects of themselves, had higher weight, sat closer to the television, and may have experienced more fear and more very stressful events or situations.

Conclusions: Our data suggest that, based on adult evaluations, myopic children have more childhood stress, and based on retrospective childhood evaluations, there is no difference in experience of certain specific childhood stressors. Our data suggest, therefore, that myopic children may have perceptual problems related to recognition and interpretation of stressful situations in their lives. Our findings point to possible unexplored risk factors for myopia and suggest complex interrelationships between psychological stress, childhood emotions, and myopia development in children.

Keywords: children, emotions, myopia, psychological stress, vision

Psychological Stress in Childhood and Myopia Development

Myopia is currently the most common human vision refractive disorder.¹ Being nearsighted has become the norm in the United States and many other countries, with rates in young adults in the United States estimated as high as 60%² and rates in east Asia estimated at 80-90% of school-leavers.³ Goldschmidt⁴ stated that “[t]he aetiology of myopia is like a puzzle in which some of the most important pieces are missing.” This study is a preliminary investigation of a possible missing piece, namely psychological stress in childhood. In light of the unprecedented prevalence rates, it is likely that there are some unexpected, unexplored, and pervasive factors involved.

Myopia has frequently been considered unalterable and resulting from inherent fault in the structure or functioning of the eye. However, as the ancient Greek physicians taught,^{5,6} the eyes, as other parts of the body, are affected by the mind, the emotions, and other aspects of mental and physical health and functioning. The eye is not an inanimate object situated in the head, but a part of the body. It would be extraordinary if the functioning of the eye was not affected by stress, as the eye has muscles, nerves, and blood flow, and stress affects all these things in other parts of the body. Vision is a cognitive process as well as a physiological process. Orfield⁷ describes in depth how myopia is intimately bound up with alterations in cognitive functioning. It is well established in psychiatry that emotions may affect vision to the extent of creating blindness,

as seen in conversion disorder.⁸ Yasuna^{9,10} describes hysterical amblyopia in children, as well as in military personnel. Gelber and Schatz¹¹ found that a very disturbing psychological event had preceded the loss of vision in 91% of patients with central serous chorioretinopathy. Harrington^{12,13} asserts that there has been “a conspicuous neglect of such evanescent qualities as psychic factors in ocular disease” and gives a large number of ocular disturbances as examples, including psychogenic ocular disorders among military personnel during World War II. He further states, “Relatively little has been written regarding the production of transient myopia by emotional disturbance such as fear or anxiety states, and yet it is a relatively common phenomenon and one which must be familiar to most ophthalmologists.” Although there have been a number of studies attempting to link adult personality factors to myopia, psychological factors that could be related specifically to the development of myopia have to date received anecdotal mention but virtually no research attention. Liberman¹⁴ and Dobson¹⁵ suggest that trauma can be the stimulus for the initial myopic deterioration of vision. Kaufman¹⁶ suggests that the onset of myopia is coincident with key psychological crises in the development of the child.

Yoo et al¹⁷ report results of vision screenings by the UCLA Mobile Eye Clinic. They found that, compared with a group of boys of the same age range who were screened at the local Boys and Girls Clubs, the abused and neglected boys at a residential facility had a significantly higher prevalence of

ophthalmologic abnormalities, including myopia (20.6% vs. 5.8%) and astigmatism (16.8% vs. 6.6%), but not hyperopia (7.6% vs. 6.2%). Garner et al.¹⁸ compared Tibetan and Sherpa children living in Nepal who shared a common ancestry and found that the Sherpa children had a myopia prevalence of 2.9% as compared with 21.7% for the Tibetan children. They concluded that the rural lifestyle of the Sherpa children appeared to be relatively unstressed and that “a simple, rural lifestyle is at least compatible with a virtual absence of myopia.” Avetisov et al.¹⁹ reported on visual examinations after the earthquake of 1988 in Armenia and concluded that an acute psychogenic stressor will affect accommodation and binocular functions, particularly in children. Basch,²⁰ using data from the National Health and Nutrition Examination Survey (NHANES) 1999-2002, found that rates of visual impairment were almost three times as high for individuals with income below the poverty level, and Kodjebacheva²¹ reported higher rates of myopia among children living in neighborhoods in California with a greater proportion of families below the poverty line. Bowan²² proposes a unifying theory of the ametropias where all refractive errors are stress adaptive responses. Correlations between stress and myopia, of course, may be due to a third factor, for example, diet or other factors.

The first author’s prior study²³ found that compared with myopes, emmetropes reported more stress and stress-related emotions between ages 6 and 13; more fresh fruits, vegetables, and whole grains in their childhood diet; and more often playing outdoors. Stress and diet were found to be independent factors approximately equal in effect; their effects appeared additive. That questionnaire evaluated stress and stress-related emotions with general questions, e.g., “At any time between age 6 and age 13, did you experience a major change and/or a major loss?” and “Between age 6 and age 13, was there any physically or emotionally traumatic, emotionally painful, very stressful, abusive, or anxiety-causing situation or event that affected you?” The counterintuitive results of that study raised the possibility of differential processing of stressful events by children who are emmetropic and myopic. Some prior literature suggests that myopic adults exhibit pervasive calm due to suppression of excitement,²⁴ more toleration of anxiety,^{25,26} and over-control of the emotions.²⁷ Yarboro²⁸ concluded that a decreased level of self-awareness is related to high myopia in adults.

We undertook in this study to extend the first author’s prior study²³ and further explore this myopia-psychological stress connection. We hypothesized that, compared with emmetropes, myopes would have a higher score on factors related to stress in a factor analysis and would report more specific stressful events and situations in their childhood.

Method

Participants and Design

Participants (n = 457) were predominantly undergraduate students enrolled in classes at Columbia State Community

College in the Spring 2012 semester. A total of 454 freshman and sophomore students in 30 classes participated. Three faculty members teaching these courses volunteered to participate, and their data is included in this study. Five of the participating classes were psychology classes taught by the first author. Other participating classes included psychology classes taught by other psychology faculty and classes in English, education, nursing, biology, early childhood education, sociology, physical education, and learning support. Recruitment and participation were in the classroom. Participants received verbal explanations of “normal vision,” nearsightedness, and farsightedness, and the difference between hyperopia in youth and presbyopia in order to be able to respond to the questionnaire item regarding refractive status. Only data comparing myopes and emmetropes was used in the subsequent analyses. Questionnaires of participants unsure of their vision status were excluded. The number of participants in each comparison group was: myopia, 199 (44%); emmetropia, 208 (46%); hyperopia (farsighted, not presbyopic), 23 (5%). There were 27 undecided participants (6%). Participants were 70% female (n = 321) and 30% male (n = 136) from predominantly white working class backgrounds. The percentage of participants by age was: age 19 or younger, 33%; age 20-24, 37%; age 25-29, 10%; age 30-39, 11%; age 40 or older, 9%.

Instruments and Procedure

Participants completed an anonymous questionnaire about their childhood perceptions and experiences and their adult perceptions of those experiences (Appendix A). There were 59 items in the questionnaire, of which 39 explored stress in childhood. The remainder were demographic or followed up on individual items in the previous study or certain factors mentioned in the literature as possibly related to myopia development. The questionnaire included 22 items that specifically asked for a response based on ages 6 through 13; 15 items which began “As a child, how did you believe...was affecting you?”; 5 items which began “Looking back on your childhood now as an adult, which would you say best describes...”; and 6 additional items that asked for the participant’s adult perspective on his or her childhood experience. The questionnaire was constructed for this study and was pilot tested on two classes. Questions were answered by marking a Likert scale with 2 to 5 choices. Almost every question had a choice of “not sure,” “don’t remember,” or “this question doesn’t apply to me.” Instructions asked participants to answer to the best of their ability, but if not reasonably sure of an answer to enter the answer “not sure.” They were specifically told not to guess and that they could omit answering any question. Additionally, participants were verbally told the importance of entering their correct vision status and that they should enter their vision status as “undecided” if they were unsure. Participants who had undergone refractive surgery were told to answer the question regarding vision status based

on their pre-surgical vision. Responses were recorded on an optical scanning form. At the conclusion of their participation, participants received a handout giving a website where they would be able to view the results of this study when available and also giving information about the results of the first author's previous study on myopia.

Childhood stress was evaluated with questions about specific factors, events, and situations that could be risk factors for stress in childhood. Also included were questions related to physical status in childhood and demographic questions. Table 1 shows a summary of the survey questions. Myopic participants were asked whether they had experienced a very stressful event or situation in certain time intervals before becoming nearsighted, their age when they first realized that they were having a problem seeing distant things, and their age at first diagnosis.

Analytic Plan

Various analyses were conducted to achieve this study's objectives. First, the factor structure for the survey items was ascertained, using exploratory factor analysis, following the suggestions of Russell²⁹ and Fabrigar et al.³⁰ More specifically, this data was subjected to parallel and exploratory-factor analyses using principal axis factoring (PAF) with Promax rotation given the anticipation that all items would have some unique/non-shared variance (PAF estimates communalities using squared multiple correlations rather than principal components analyses which assumes no unique-variance by fixing communalities to 1.0) and that the extracted factors would be correlated (Promax rotation begins assuming uncorrelated factors, then allows factors to correlate as needed). To determine the number of factors to extract, a parallel analysis³¹ was conducted. Parallel analyses reduce the subjectivity associated with visual inspection of the scree plots by plotting the eigenvalues from chance data and data derived from factoring a completely random set of data involving the same number of items and research participants. The point at which the eigenvalues for the actual data dropped below eigenvalues for the random data indicate that one less factor is optimal or not due to chance. Items were retained when their factor loading was greater than 0.30.³² If multiple loading occurred, the item was retained on the factor with the highest loading. If items diverged conceptually from the factor, an item was removed. One-way Analysis of Variance (ANOVA) was used to determine differences on factors due to refractive status.

Results

Demographics and Vision

Surveys were collected from a total of 457 participants, with 208 reporting normal vision (emmetropia) and 199 reporting nearsightedness (myopia). The myopia group was 72% female, and the emmetropia group was 68% female. The myopia and emmetropia groups were not different in

Table 1. Questionnaire Items

Risk Factors for Stress in Childhood

5. Being an only child
8. Number of friends
11. Being teased or bullied
19. Time alone after school
20. Time alone on weekend
21. Living with only one biological parent
22. Parent living elsewhere who didn't give love and support
23. Self-esteem level
24. Loneliness
25. Not having a close extended family
26. Few or no visitors to home
27. Comparison with other children
28. Situations causing continuous stress
30. Parents' perceived marital happiness
31. Parent with serious illness
32. Parent with emotional instability
33. Parent addicted to alcohol or drugs
35. Family moving a lot
36. Being the only one or one of a few in class, neighborhood, etc.
- 37, 38. Number of very stressful events or situations
39. Situations causing fear
40. Degree of threatened harm
- 41, 42. Situations causing abuse or neglect
45. Talk with others about stressful event or situation
46. Help from others when dealing with stressful events
47. Little interaction with parents
- 48, 49, 50. Praise, including frequency and type
- 51, 52, 53. Criticism, including frequency and type

Physical Status in Childhood

9. Childhood height
10. Childhood weight
12. Sit or play on the floor or ground
13. Distance sat from television
14. Frequency of eating fresh picked fruits and vegetables
15. Frequency of taking multivitamins
16. Frequency of eating organic fruits and vegetables
17. Frequency of eating fresh protein food
18. Type of water drank
54. Wisdom teeth
55. Breathing

Demographic Questions

2. Gender
3. Age
4. Birth order
56. Season of birth

terms of gender, $\chi^2 (1) = 1.01, p = 0.31$; age, $\chi^2 (3) = 2.981, p = 0.40$; or being an only child (myopia group: 11.6% vs. emmetropia group: 6.7%), $\chi^2 (1) = 2.87, p = 0.09$. The myopia group reported the following age-bracket percentages: 35%, <19 years; 34%, 20-24 years; 11%, 25-29 years; 14%, 30-39 years; and 6%, >40 years old. The emmetropia group reported the following age-bracket percentages: 32%, <19 years; 39%, 20-24 years; 9%, 25-29 years; 9%, 30-39 years; and 11%, >40 years old.

Results of Factor Analysis

The parallel analysis conducted for this study indicated that a six-factor solution was most appropriate. Exploratory factor analysis (EFA) was then conducted, with the six-factor solution accounting for 45.7% of the item variance. Upon review of item content, item 23 (related to self-esteem during childhood) was dropped from the scale because it diverged

Table 2: Descriptive Statistics for the Factor Scores for the Myopia Group, Emmetropia Group, and Total Sample

Factor	Group	N	Mean	Std. Deviation
Stress-Fear-Abuse	Myopia	199	2.23*	0.80
	Emmetropia	208	2.07*	0.84
Praise-Support	Myopia	199	2.56	0.75
	Emmetropia	206	2.62	0.72
Social Contact	Myopia	198	3.33	0.55
	Emmetropia	208	3.40	0.60
Fresh-Organic Food	Myopia	193	1.72	0.87
	Emmetropia	203	1.85	1.00
Realistic Understanding as Child	Myopia	182	2.03	0.76
	Emmetropia	189	1.96	0.81
Criticism as Child	Myopia	184	-0.02	0.46
	Emmetropia	191	0.01	0.54
Total Stress	Myopia	199	5.12	3.21
	Emmetropia	208	4.54	3.46

*Significantly different at $p < 0.05$

from other item content and had the lowest factor loading. Appendix B shows the items and pattern factor item loadings and factor internal consistencies. Based on the content of the remaining items, the six factors were named: 1) Stress-Fear-Abuse, 2) Praise-Support, 3) Social Contact, 4) Fresh-Organic Food, 5) Realistic Understanding As Child, and 6) Criticism As Child. Factor Scores were computed taking the average of scale items (or the average of z-scores, when items were measured on different scales) and scored such that higher values reflected more endorsement of the named construct (e.g., higher scores on Stress-Fear-Abuse indicates higher endorsement of experiencing stress, fear, and abuse as a child).

In terms of group comparisons on the various factors, the myopia group was found to have significantly higher scores on the Stress-Fear-Abuse scale ($F(1,405) = 4.328, p = 0.043$, Cohen's $d = 0.20$) compared to the emmetropia group. No significant differences were found on:

- Praise-Support, $F(1,403) = 0.655, p = 0.42, d = 0.08$
- Social Contact, $F(1,404) = 1.427, p = 0.23, d = 0.12$
- Fresh-Organic Food, $F(1,394) = 1.60, p = 0.18, d = 0.14$
- Realistic Understanding As Child, $F(1,369) = 0.729, p = 0.39, d = 0.09$
- Criticism As Child, $F(1,374) = 0.437, p = 0.51, d = 0.07$

Descriptive statistics for the six factors per group can be found in Table 2.

Additional Analyses

In order to compare the myopia and emmetropia groups in terms of an overall stress score, a stress total score was computed taking the sum of items in which participants endorsed some (vs. no) stress; however, no significant differences were found on the total reported Stress Score ($F(1,405) = 3.04, p = 0.082, d = 0.17$). To compare a possible differential effect of refractive

status on males vs. females or age groups (younger vs. older) on the stress total and factor scores, two MANOVAs were conducted using gender, refractive status, and the gender X refractive status interaction; and the age, refractive status, and the age X refractive status interactions, respectively. The effect of refractive status was the same for males and females ($F(7,325) = 0.599$, Wilks' Lambda = 0.987, $p = 0.756$) as it was for the younger or older age groups ($F(7,292) = 0.594$, Wilks' Lambda = 0.986, $p = 0.760$).

In order to generate additional hypotheses for future research, non-parametric tests were conducted to determine whether the vision groups differed in their responses to questionnaire items 5-55. A Bonferroni adjusted alpha level was used for multiple comparisons (e.g., 0.05/51). This correction avoids reporting chance findings but reduces statistical power. Of these questions (Table 3), the vision groups had different responses to five items, with the myopia group reporting greater weight in childhood (Q10), closer TV viewing in childhood (Q13), relatively lower self-esteem (Q23), greater loneliness on occasion (Q24), and greater childhood criticism on physical aspects (hair, height, bad at sports, etc.; Q53).

Discussion

This survey study found significant differences between myopes and emmetropes.

1. In a factor analysis, the myopia group had a significantly higher score on the Stress-Fear-Abuse scale than the emmetropia group.
2. Exploratory analyses suggested that myopes in their childhood had lower self esteem, were more lonely, experienced more criticism about physical aspects of themselves, had higher weight, and sat closer to the television.

Table 3: Exploratory Analyses and Results

Questionnaire Item	Myopia	Emmetropia	
10. Between age 6 and age 13, which best describes you?	%	%	d
a. below average weight for your age	11.2	23.7%	-0.50
b. average weight for your age	52.6	57.0	-0.11
c. above average weight for your age	30.6	15.5	0.51
d. not sure/don't remember/varied too much to answer	5.6	3.4	0.24
13. Between age 6 and age 13, how far away did you sit from the television?			
a. very close to the television (less than 6 feet)	23.7	7.7	0.71
b. about 6 feet from the television	39.7	45.4	-0.05
c. more than 6 feet from the television	24.7	32.4	-0.09
d. not sure/don't remember	11.9	14.5	-0.06
23. Between age 6 and age 13, which best describes how you felt about yourself?			
a. I had very low self-esteem during that entire time	5.5	9.1	-0.26
b. I had very low self-esteem during some of that time	16.6	11.1	0.25
c. I had low self-esteem during some of that time	44.7	32.2	0.33
d. I had good self-esteem during that entire time	28.6	44.2	-0.42
e. not sure/can't remember	4.5	3.4	0.13
24. Looking back on your childhood now as an adult, which would you say best describes how you probably felt as a child? (this is not necessarily what you would have said when you were a child)			
a. lonely most of the time or a lot of the time (e.g., most days)	11.6	12	-0.02
b. lonely sometimes or occasionally (e.g., once a week)	26.1	12.5	0.51
c. rarely lonely (e.g., a few times a year)	35.7	36.1	-0.01
d. never lonely	25.1	37	-0.34
e. not sure/don't remember	1.5	2.4	-0.19
53. Which best describes the type of criticism you received as a child?			
a. It was usually about something physical (e.g., your hair is unattractive, you are too short, you are bad at sports)	20.1	6.7	0.66
b. It was usually about something psychological or social (e.g., you are too shy, you are selfish, you are never going to be successful)	18.1	16.3	0.07
c. It was equally about something physical and something psychological or social	24.6	26	-0.04
d. I was criticized rarely or never	25.1	37	-0.34
e. don't remember/not sure	12.1	13.9	-0.09

Note: Cohen's d = ~.2/.5/.8 small/medium/large

3. Exploratory analyses suggested that myopes in their childhood may have experienced more fear and more very stressful events or situations.
4. Our data suggest that (1) based on adult evaluations, myopic children have more childhood stress, and (2) based on retrospective childhood evaluations, there is no difference in experience of certain specific childhood stressors. Taken together, our data suggest that differences in perceived stress level appear to emerge only when adults reflect upon their childhood experiences, and that during childhood (based on retrospective report in adulthood) there may not be differences in perceived stress level due to refractive status.

As predicted, the myopia group had a higher score on the Stress-Fear-Abuse factor in a factor analysis. Of the 8 items in

this factor, 7 specifically asked for adult evaluation of childhood stressors. These 8 questions evaluated frequency of childhood stress, fear, abuse, neglect; number of very stressful events or situations (adult and childhood evaluations); and seriousness of threat of harm. This significant finding is consistent with the limited and largely anecdotal literature in this area.¹⁴⁻¹⁷

Katz & Lambert²³ found that emmetropes reported more stress and stress-related emotions between ages 6 and 13 than did myopes, using a survey that did not ask for adult or childhood evaluation of stress and did not evaluate severity or intensity of stress. Our study's survey questions generally asked for childhood or adult evaluation of stress and attempted to evaluate severity and intensity of stress. In fact, our study found a significant difference between myopes and emmetropes, with adult myopes reporting significantly higher stress in childhood than adult emmetropes in adult evaluations based on their current adult understanding. However, in their retrospective

childhood evaluations of their experience of specific childhood stressors based on their childhood understanding, there was no significant difference between myopes and emmetropes. Therefore, based on our findings, there is preliminary evidence that adult myopes do not retrospectively perceive their childhood stress level as different compared to adult emmetropes' retrospective reports. It is possible that parallel to perceptual problems with vision, children who develop myopia have perceptual problems related to recognition and interpretation of stressful situations in their lives.

An unexpected result was that differences between myopes and emmetropes were not found in the 15 items that asked for retrospective childhood evaluation of specific stressful *events*, but rather in specific childhood *emotions*. Myopes reported experiencing in childhood less self-esteem, more loneliness, and more criticism of their physical aspects (e.g., "your hair is unattractive, you are too short, you are bad at sports"). Myopes reported higher frequency of fear (adult evaluation; $p = .02$) and higher number of very stressful events or situations (retrospective childhood evaluation, $p = .01$); these two latter items were not significant after a Bonferroni adjustment for multiple comparisons requiring $p < 0.0009$. However, these two items were items in the significant "Stress-Fear-Abuse" Factor and merit more research. In fact, myopic participants more often reported experiencing three or more "very stressful events or situations" in their childhood in both adult evaluation (44%) and retrospective childhood evaluation (46%) than emmetropic participants (38%, 33%). It is not possible to know from our data whether myopes' experience of these specific emotions preceded or followed the beginning of their myopia; however, it is possible that loneliness, fear, criticism, and low self-esteem may be important factors related to myopia development, and we believe that these provocative findings merit further research. Since loneliness can be a risk factor for experience of fear, it is noteworthy that myopes reported higher experience of both of these. We suggest that our significant findings may be connected, and we suggest these possible connections for further study. For example, a child who experiences stress, fear, or abuse may withdraw from playing with other children and may become lonely and experience lowered self-esteem. Due to withdrawal from active play outside and possibly a poor diet at such a time, overweight may develop. Criticism could lead to low self-esteem, and low self-esteem could lead to withdrawal from others and loneliness. Myopes reported greater childhood weight and sitting closer to the television in childhood. It is not possible to determine from our data if these preceded or followed the beginning of their myopia; it is certainly possible that myopia could lead to less physical activity with consequent weight gain and difficulty seeing the television.

No statistically significant difference was found in rates of being an only child for the myopia group (11.6%) relative to the emmetropia group (6.7%), $p = 0.09$. However, our only children sample was small ($n = 37$), and as loneliness

may be an important issue for many only children, we believe this merits further study with a larger sample. Some studies have found summer birth a factor with myopia development, especially high myopia.^{33,34} Although we found that myopes were most likely to be born in summer (June, July, August) and emmetropes were most likely to be born in fall (September, October, November), the difference was not significant. Based on the findings related to myopia and diet of Katz and Lambert,²³ we suggest that mother's diet during pregnancy may be the associating mechanism. A child born in July was conceived in October, and the critical first months of gestation are during the winter months, during which time a mother may be expected to be eating fewer fresh fruits and vegetables. A child born in January was conceived in April, and the critical first months of gestation would be during the spring and summer months when a mother may be expected to be eating more fresh fruits and vegetables. Consistent with other studies,^{23,35} we found that more women than men were myopic, but the difference in this study was not significant. Consistent with various recent studies,^{23,36} time spent outdoors may be a significant factor in reducing myopia risk in childhood, and it is likely that boys spend more time outdoors than girls.³⁷ Also, girls may experience more traumatic stress overall than boys³⁸ and may internalize their response to trauma more than boys.³⁹

If our preliminary findings related to psychological stress and myopia development are confirmed by future studies, the physiological and psychological mechanisms involved can then be explored. For example, stress, by affecting respiration, posture, and muscle tension, may lead to less oxygenation of the eyes and brain. A larger pupil, caused by suspension of breathing and acceleration of heartbeat,⁴⁰ could be involved. Experience of strong emotions may directly lead to myopia by affecting the brain.^{8,14} Certainly if stress can cause the blindness of conversion disorder, it is possible that it could cause blurring of vision; such blurring may then induce myopia.⁴¹ As wearing of glasses affects the light reaching the retina, and consequently affects messages being received by the brain, it is possible that this in some way could affect cognitive or emotional functioning, thus affecting myopes' recognition of stressful situations in their lives.

One limitation of this study is that some of the questions used retrospective self-report. Participants self-reported their refractive status, and therefore it is likely subject to inaccuracy. Some participants who self-reported as emmetropes could instead have been low myopes or low hyperopes. Since we did not have independent evaluation of the magnitude of participants' myopia either in childhood or at the time of their participation, we were not able to evaluate an expected dose-response relationship; a future study should explore this. Another limitation is that almost all of the participants were undergraduate students from one institution, limiting generalizability. The results are correlational and retrospective; characteristics that distinguish myopes and emmetropes may be etiological, may be the result of the myopia, or may,

along with the myopia, be caused by another factor. Also, in some cases there may be an intervening variable; for example, stress may lead to impaired nutritional status, and impaired nutritional status may be the cause of the myopia rather than stress itself. Also, myopes and emmetropes may have consistent differences in memory, perception, or interpretation that have affected our results.

Suggestions for future studies include prospective longitudinal studies that evaluate children's psychological approach to stress and whether there are changes in perception or processing of stress, or in number and intensity of stressful events, around the time a child develops myopia. In-depth interviews of myopic and emmetropic adults related to stressors and psychological issues during their childhood could yield insights. Interviews with older adults may be most fruitful, as they may encompass the benefits of many years of adult reflection and experience. Interviews could develop data on the timeline of events and establish whether a certain factor preceded or followed myopia onset. Emmetropic participants, as compared to myopic participants, reported receiving overall less childhood criticism and less often having parents with health, emotional, addiction, or marital problems. Research to further explore these findings may be fruitful.

We believe that there has been an historical focus on a limited number of possible risk factors for myopia and that correlations, such as with schooling, reading, and parental myopia, have at times been presumed to be etiological links in the absence of other etiological possibilities. We believe that there are many risk factors related to myopia development, including stress, diet, posture, and outdoor activity, that may have independent effects that are additive, sometimes one being of sufficient etiological intensity for a particular individual, but probably a number of factors being involved in most cases. The limited literature and our study suggest that there may be complex interrelationships between psychological stress and trauma and myopia development and that research in this area is needed. A substantial difference in the lives of children may result from increased awareness that stress can affect a child not only emotionally, but also physically, and in ways seldom suspected, such as myopia.

Acknowledgements

A preliminary version of the findings of this study was presented at the 2013 Tennessee Psychological Association Convention in Nashville, Tennessee in October 2013.

This research was supported in part by a financial contribution from Columbia State Community College. We thank Warren Lambert, Ph.D. and Sean Donahue, M.D., Ph.D. for their review of the manuscript and many helpful suggestions. We also thank faculty members at Columbia State Community College for their assistance with recruitment of participants.

Requests for copies of Appendix A, the questionnaire used in the study, and Appendix B, additional details from the exploratory factor analysis (Items, Item Factor Loadings,

Internal Consistencies, etc.), should be addressed to the corresponding author or found in the online version of this article at www.ovpjournal.org.

References

1. Leo SW, Young TL. An evidence-based update on myopia and interventions to retard its progression. *JAAPOS* 2011;15:181-9.
2. Framingham Offspring Eye Study Group. Familial aggregation and prevalence of myopia in the Framingham Offspring Eye Study. *Arch Ophthalmol* 1996;114:326-32.
3. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. *Lancet* 2012;379:1739-48.
4. Goldschmidt E. The mystery of myopia. *Acta Ophthalmol (Scand)* 2003;81:431-6.
5. Salovey P, Rothman AJ, Detweiler JB, Steward WT. Emotional states and physical health. *American Psychologist* 2000;55:110-21.
6. U.S. National Library of Medicine. Emotions and disease: The balance of passions. 2011. Retrieved from: <http://1.usa.gov/1xcdOKe> Last Accessed September 11, 2014.
7. Orfield A. Seeing space: Undergoing brain re-programming to reduce myopia. *J Behav Optom* 1994;5:123-31.
8. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (Fifth Edition). Arlington, VA: American Psychiatric Association, 2013.
9. Yasuna ER. Hysterical amblyopia in children and young adults. *AMA Arch Ophthalmol* 1951;45:70-6.
10. Yasuna ER. Hysterical amblyopia in children. *Am J Dis Child* 1963;106:558-63.
11. Gelber GS, Schatz H. Loss of vision due to central serous chorioretinopathy following psychological stress. *Am J Psychiatry* 1987;144:46-50.
12. Harrington DO. Wartime ocular neuroses. *J Nervous Mental Disease* 1944;99:622-30.
13. Harrington DO. Psychosomatic interrelationships in ophthalmology. *Am J Ophthalmol* 1948;31:1241-51.
14. Liberman J. *Take Off Your Glasses and See: A Mind/Body Approach to Expanding Your Eyesight and Insight*. New York: Three Rivers Press, 1995.
15. Dobson JP. Emotional background of myopia. *J Aviation Med* 1949;20:365-70.
16. Kaufman F. Myopia seen psychoanalytically. *Psychoanal Rev* 1963;50:24-39.
17. Yoo R, Logani S, Mahat M, Wheeler NC, Lee DA. Vision screening of abused and neglected children by the UCLA Mobile Eye Clinic. *J Am Optom Assoc* 1999;70:461-9.
18. Garner LF, Owens H, Kinnear RFS, Frith MJ. Prevalance of myopia in Sherpa and Tibetan children in Nepal. *Optometry & Vision Science* 1999;76(5):282-5.
19. Avetisov ES, Gundorova RA, Shakarian AA, Oganessian AA. Effects of acute psychogenic stress on the state of several functions of the visual analyzer. [Article in Russian] *Vestn Oftalmol* 1991;107:17-9.
20. Basch CE. Vision and the achievement gap among urban minority youth. *J School Health* 2011;81:599-605.
21. Kodjebacheva GD. Visual impairment and myopia among first graders from three school districts in Southern California: Racial/ethnic disparities, yearly trends, geospatial distribution, and relative influence of individual, neighborhood, and school determinants (Doctoral dissertation). Available from ProQuest Dissertations and Theses database. 2009.
22. Bowan MD. Stress & eye: New speculations on refractive error. *J Behav Optom* 1996;7:115-22.
23. Katz L, Lambert W. A new look at myopia development: Possible links with childhood stress and diet. *J Behav Optom* 2011;22:69-73.
24. Palmer RD. Visual acuity and excitement. *Psychosomatic Med* 1966;28:364-74.

25. Lanyon RI, Giddings JW. Psychological approaches to myopia: A review. *Am J Optom & Physiol Optics* 1974;51:271-81.
26. Rosanes MB. Psychological correlates to myopia compared to hyperopia and emmetropia. *J Projective Techniques & Personality Assessment* 1967;31:31-5.
27. Schapero M, Hirsch MJ. The relationship of refractive error and Guilford-Martin temperament test scores. *Am J Optom Arch Am Acad Optom* 1952;29:32-6.
28. Yarboro KI. The eye of the beholder: The relationship between self-awareness and nearsightedness (Doctoral dissertation). 2008. <http://bit.ly/1xARvsW>
29. Russell DW. In search of underlying dimensions: The use (and abuse) of factor analysis in Personality and Social Psychology Bulletin. *Personality and Social Psychology Bulletin* 2002;28:1629-46. <http://bit.ly/1th5a6j>
30. Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods* 1999;4:272-99.
31. Reise SP, Waller NG, Comrey AL. Factor analysis and scale revision. *Psychological Assessment* 2000;12:287-97.
32. Tabachnick BG, Fidell LS. *Using Multivariate Statistics*, 6th edition. Boston: Allyn and Bacon, 2013.
33. Mandel Y, Grotto I, El-Yaniv R, Belkin M, et al. Season of birth, natural light, and myopia. *Ophthalmology* 2008;115:686-92.
34. McMahon G, Zayats T, Chen YP, Prashar A, et al. Season of birth, daylight hours at birth, and high myopia. *Ophthalmology* 2009;116:468-73.
35. Sperduto RD, Seigel D, Roberts J, Rowland M. Prevalence of myopia in the United States. *Arch Ophthalmol* 1983;101:405-7.
36. Sherwin JC, Reacher MH, Keogh RH, Khawaja AP, et al. The association between time spent outdoors and myopia in children and adolescents: A systematic review and meta-analysis. *Ophthalmology* 2012;119:2141-51.
37. Baranowski T, Thompson WO, Durant RH, Baranowski J, Puhl J. Observations on physical activity in physical locations: Age, gender, ethnicity, and month effects. *Res Quart Exercise Sport* 1993;64:127-33.
38. Finkelhor D, Hotaling G, Lewis IA, Smith C. Sexual abuse in a national survey of adult men and women: Prevalence, characteristics, and risk factors. *Child Abuse and Neglect: The International Journal* 1990;4:19-28.
39. Dulmus CN, Hilarski C. Significance of gender and age in African American children's response to parental victimization. *Health & Social Work* 2006;31:181-8.
40. Duke-Elder WS. *Text-book of Ophthalmology* (Vol. IV). London: Henry Kimpton, 1949.
41. Gwiazda J, Thorn F, Bauer J, Held R. Myopic children show insufficient accommodative response to blur. *Invest Ophthalmol Vis Sci* 1993;34:690-4.

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Katz L, Berlin KS. Psychological Stress in Childhood and Myopia Development. *Optom Vis Perf* 2014;2(6):289-96.

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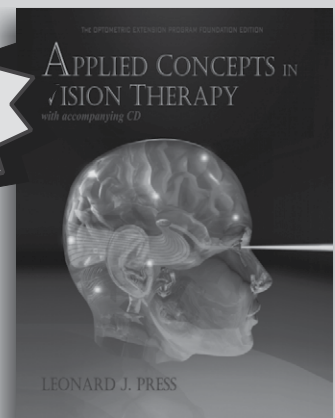
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