

ASSESSMENT OF THE RISK OF CHILDHOOD STRESS AND THE DEVELOPMENT OF MYOPIA AMONG SENIOR HIGH SCHOOL STUDENTS IN GHANA

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Abstract: Myopia is a global public health problem leading to visual impairment and blinding complications. It is the most common type of refractive error and is a complex trait including both genetic and environmental factors. Numerous studies have been conducted to elucidate the aetiology of myopia. The objective of this study was to determine the effect of childhood stress on the occurrence of myopia among senior high school students in Ejisu-Juaben Municipality of Ghana. The study was a cross-sectional study of students attending senior high schools in the Municipality. Students were selected by systematic and simple random sampling methods. Questionnaires were administered to all students and non-cycloplegic refraction was carried out for all students who failed the plus one blur test or with improvement of vision with a pin hole on the Snellen chart. Myopia for purposes of this study was defined by the investigators as spherical error of at least -0.50 diopters in one eye. The prevalence of myopia among the student was 34%. Childhood stress was associated with the occurrence of myopia. The study showed students who experience significant childhood stress are 3 times more likely to develop myopia compared to children who do not experience significant childhood stress. This study concludes that myopia is a significant cause of visual impairment among senior high school students in the Sekyere East District of Ghana, and is therefore an issue of public health concern among senior high school students in the district. Counseling services should be strengthened from basic education through to senior high school. Children during the teenage years have many challenges and feel the effects of stress. Times of special changes like divorce, a death in the family, or a move can be stressful. Effective counseling in schools is needed to support parents and guardians to adjust students to stress.

Keywords: Myopia, childhood stress, senior high schools, public health, parents and guardians.

1. INTRODUCTION

Myopia, the most common type of refractive error, is a complex trait including both genetic and environmental factors. Numerous studies have tried to elucidate the aetiology of myopia. However, the exact aetiology of myopia is still unclear (Pan, 2011). Old-fashioned traditional medicine state that myopia is an inherited condition and the only solution is to prescribe glasses. In many papers, however, it was reported that today very many people are becoming myopic even though their parents or grandparents were not. On the other hand, life today is very different from that of our ancestors – just to mention the changed working environment and changed nutrition. Therefore, it is rather obvious that these changes in the environment have an impact on the incidence of myopia.

Myopia is the refractive anomaly of the eye in which the conjugate focus of the retina is at some finite point in front of the eye, when the eye is not accommodating. It can also be described as the refractive condition in which parallel light rays from an object at optical infinity are focused by the eye in front of the retina, with accommodation relaxed (American Optometric Association, 1997).

Myopia results from an eye having excessive refractive power for its axial length. This may be due either to the eye having a relatively long axial length or to increased dioptric power of one or more of the refractive elements (Goldschmidt, 1968). Aristotle is credited with first distinguishing nearsightedness. However the term myopia was derived by Galen from the words *myein* (to close) and *ops* (eye) (Borish, 1970).

Myopia presents with various symptoms depending on the vocation of a person and its associated visual demand. The most common symptom associated with uncorrected myopia is blurred distance vision. Myopia can be classified as simple myopia, nocturnal myopia, degenerative myopia or induced myopia. (American Optometric Association, 1997).

In emmetropic eyes, axial length and optical power are inversely correlated. An eye with greater than average optical power can be emmetropic if it is sufficiently shorter than average, as can an eye with less than average optical power if it is sufficiently longer than average. An eye with myopia is an otherwise normal eye that is either too long for its optical power or, less commonly, too optically powerful for its axial length. Corrected visual acuity may be reduced as a result of pathological changes in the posterior segment (American Optometric Association, 1997).

Myopia appears with greater prevalence in young children (Saw, 2002; Lin, 2004) which places these children at greater risk of developing high myopia, with its associated complications. Due to these trends in the prevalence of myopia, there has been a research focus on factors that could increase the risk of myopia. It is well established that the prevalence of myopia in children is greater if their parents are myopic. (Saw, 2002; Zadnik, 1997) but current studies according to Schmid (2013) indicate that this may not always be the case.

According to Morgan (2005), East Asian ethnicity has also been proposed as a possible risk factor. He further goes on to intimate that myopia is generally believed to have a multifactorial etiology. The rapid rise in the prevalence of myopia suggests that rapidly changing environmental factors are predominant in determining the current patterns of myopia.

Problem Statement:

Myopia is a global public health problem leading to visual impairment and blinding complications (Saw, 2005). According to American Optometric Association, (1997), myopia is the most common eye disorder in the world. Mavracanas, (2000) and Pararajasegaram, (1999) have shown that refractive error, and myopia in particular, is one of the five leading causes of visual impairment in the world. Kempen et al, (2004) estimated that, by the year 2020, approximately one third of the world's population (2.5 billion) will be affected by myopia alone. High myopia (myopia greater than minus 6 diopters) may be associated with glaucoma, cataract, retinal degeneration and myopic macular degeneration (American Optometric Association, 1997).

Abnormal or adverse ocular changes in degenerative myopia can include vitreous liquefaction, posterior vitreous detachment and peripapillary atrophy appearing as temporal choroidal or sclera crescents or rings around the optic disc (Goldschmidt, 1990). According to Celorio, (1991), other adverse ocular changes also includes lattice degeneration in the peripheral retina, tilting or malinsertion of the optic disc, usually associated with myopic conus, thinning of the retinal pigment epithelium with resulting atrophic appearance of the fundus, ectasia of the sclera posteriorly (posterior staphyloma), breaks in Bruch's membrane and choriocapillaris, resulting in lines across the fundus called "lacquer cracks", and Fuchs' spot in the macular area.

The observation of some of the ocular changes in isolation does not necessarily indicate pathological myopia. For example, small choroidal crescents on the temporal side of the optic disc are often seen in simple myopia. Patients with degenerative myopia may complain of floaters or flashes of light associated with retinal changes. Patients with myopia are more likely to have a retinal detachment than patients with hyperopia, and the risk for retinal detachment increases as myopia increases (Perkins, 1975).

Myopia may have substantial social, educational, economic and personal consequences (Orfield, 2007; Saw, et al 1996). The American Optometry Association, (1997) indicates that because myopia is associated with reduced distance vision without optical correction, it can be a limiting factor in occupational choices.

Hypothesis of Axial Length Growth of the Eye :

During normal ocular development in children and young adults, the axial length of the eye must closely match its optical power to ensure that the retinal image is properly focused. If the eye grows too rapidly, the image will be focused in front of the retina and the subsequent eye growth will tend to be slower. If the eye grows too slowly, however, the retinal image will be focused behind the retina, and the subsequent eye growth will tend to be faster. (Grosvenor and Goss, 1998).

The continuous biological process that attempts to balance optical power and axial growth of the eye is known as emmetropization (Yackle and Fitzgerald, 1999). Kee et al., (2007) have shown that certain exposures such as excessive near work may hinder an eye from being emmetropized. According to Parssinen (1993), tasks of high accommodative demand such as reading and writing elicits side-to-side movement of the eyes precipitating in myopia as found in *Cohn's use-abuse theory*.

Hypothesis of Stress and Myopia:

Toxic stress can impair the connection of brain circuits and, in the extreme, result in the development of a smaller brain. Brain circuits are especially vulnerable as they are developing during early childhood. Toxic stress can disrupt the development of these circuits. This can cause an individual to develop a low threshold for stress, thereby becoming overly reactive to adverse experiences through-out life. High levels of stress hormones, including cortisol, can suppress the body's immune response. This can leave an individual vulnerable to a variety of infections and chronic health problems. (National Scientific Council on the Developing Child. Cambridge, 2005).

According to Elias (1989) school stress, stressful school environments have been linked to children's experiencing inordinate amounts of fatigue and headaches which can hinder the normal growth of organs and tissues in the body. Psychological stress has been associated with poor health in individuals across the life span and in many countries (Lin & Ensel, 1989; Marmot & Wilkinson, 1999). It is well established that psychological conflicts or other stressors can sometimes produce temporary blindness (American Psychiatric Association, 2000); therefore, it is possible that mental and emotional states experienced from childhood may influence vision, axial length, refractive power of the eye and the whole process of emmetropization.

Balacco-Gabrieli and Tundo (2000) detected significant high level of cortisol in myopes. According to Rosemond (2000), cortisol level increases under transient stress and after long-term exposure to stress; however, this is followed by a decrease of the cortisol output. Cortisol has a high impact on connective tissue by mediating reactions of the immune system, e.g. by decreasing inflammations, and by creating structurally defective connective tissue. (Trichtel and Zur, 1986). Stress may therefore be responsible for long axial length in myopes.

2. LITERATURE REVIEW

Myopia has been broadly classified as pathological and by age of onset as school age, or adult onset. Pathologic myopia, which usually presents before six years of age, is caused by abnormal and extreme elongation of the axial length of the eye, generally does not progress, and is usually associated with early retinal changes (Curt, Iwamoto and Renaldo, 1979).

School age myopia occurs between 6 and 18 years of age and is thought to progress and stabilize by the late teens or early twenties (Morgan and Rose, 2005). According to Jones et al, (2005) and Wu et al, (2010), school age myopia is associated with higher intelligence quotient scores, more time spent reading, and less hours of exposure to sunlight as compared to non-myopic patients.

American Optometry Association, (1997) indicates that adult onset myopia occurs between 20 and 40 years of age (early adult onset) or after 40 years of age (late adult onset). It has different characteristics as compared to the school age onset myopia; specifically it is associated with focusing anomalies and near vision dominated occupations such as computer viewing (Simensen and Thorud, 1994). Myopia progression in all three groups of pathological, school age and adult onset is due to the elongation of the eye ball, resulting in the eyeball becoming egg shape (Hosaka, 1988).

The concept that myopia evolved from the use and abuse of the eyes during near vision activities was first described by Cohn in 1886 and has been traced back to Kepler (Rosenfield and Gilmartin, 1998). The assumption in most use and abuse theories is that near vision focusing such as reading and writing is somehow indirectly responsible for axial length elongation. Thus those near activities can bring about the onset of myopia.

Myopia and Childhood Stress:

A review by Cordain, Eaton, Miller et al. (2002) of studies of myopia in primitive, urban, and rural groups, concludes that environmental factors may play a role in the etiology of myopia. Morgan and Rose (2005) give comprehensive evidence for an environmental component based on urbanization. In fact, urbanization would be expected to create a multiplicity of changes in children's lifestyles including less physical activity, more schooling and less time outdoors; exposure to artificial light; more noise; more pollution, etc.

Based on literature, there is reason to believe that environmental factors including stress may play a part in the etiology of myopia (Yoo et al 1999). Since myopia has already been shown to develop early in life, childhood stress may play an important factor in the development of myopia. The relationship between childhood stress and myopia has however been given little attention in literature. Balacco-Gabrieli and Tundo (2000) have demonstrated that significant high levels of cortisol have been produced by transient and long-term exposure to stress in myopes.

A study in the United States by Katz (2009) shows that myopic participants who were undergraduate students reported significantly less childhood stress compared to emmetropic (normal vision) participants, raising the possibility of differential processing of stressful events of myopes compared to emmetropes. A limitation reported for this study was that participants were undergraduate participants from one institution, limiting generalizability of the results. Participants in this study were neither subjected to objective nor subjective refraction but depended on the individual's complaint to be classified as myopes or otherwise.

3. METHODOLOGY

The study was carried out in schools and it was a cross-sectional study of students attending senior high schools in Sekyere East District of Ghana. Ejisu-Juaben Municipal is one of the 30 administrative and political Districts in the Ashanti Region of Ghana. The total number of students in the six schools is around 5000.

The district has six senior high schools. These are Tweneboa Kodua Secondary School, Juaben Secondary School Ejisuman Secondary School Ejisu Secondary Technical School Bonwire Secondary Technical School Achinakrom Secondary School Church of Christ Senior High School Between 2013 and 2015, the total enrolment in schools increased from 4040 to 4785. 315 students were selected by systematic and simple random sampling.

Data Collection Techniques and Tools:

Institutional Ethics approval to carry out the study was obtained from the Committee on Human Research, Publications and Ethics of the Kwame Nkrumah University of Science and Technology (KNUST). Additionally, permission was sought and obtained from the local health service authority in the district. Authorities of senior high schools were asked for permission for students to participate in the study and heads of selected schools were briefed on the purpose of the research.

Before commencement of field work, the clinical team was briefed on the purpose of the study and received training on carrying out Visual Acuity Tests. Members of the research team were also made conversant with the instructions required in filling out questionnaire. The questionnaire was designed with the help of an ophthalmologist. The views which were obtained were used to modify the questionnaire accordingly and these were administered to all students by trained members of the research team who explained the purpose of the study and how to complete the questionnaire properly. The students were asked to fill the questionnaire independently and in privacy.

The students were asked to fill the questionnaire independently and in privacy. The questionnaire ascertains the number of hours reading and writing outside the classroom and their experience on stressful environments and experiences. The questionnaire also ascertained the knowledge, attitude and perception of spectacle.

Consent forms were signed by students before Visual Acuity Tests were conducted. Non-cycloplegic refraction was done where appropriate and final prescription and the best-corrected Visual Acuity were recorded. Students afterwards took their time to fill questionnaire in private. Information on visual acuity and ophthalmic refraction was collected on the filled questionnaire and checked for completeness.

Clinical Examination:

Non-cycloplegic refraction was carried out for all students who failed the plus one blur test or with improvement of vision with a pin hole on the Snellen chart. This is similar to the protocol used by Adegbehingbe et al. (2005) in their study of students in Nigeria in order not to disrupt academic work for the day used non-cycloplegic method of refraction. To ensure that accommodation was relaxed, a +1.50 D lens was used to fog the eye monocularly during refraction.

Visual acuity (VA) was measured with the Snellen chart at a distance of 6 metres. Children who wore glasses also had their VA taken while they removed their glasses and refracted. Students who read 6/9 or worse were refracted. Those who read 6/6 or better had their VA measured again with a +1.50 D. If the VA was 6/9 or worse they were also refracted.

Ethical Consideration:

In this research study, the students were assured of the confidentiality of information given. Informed consent was sought from participants. Participants were also assured that they will have the right to withdraw from the study at any stage and will not suffer any consequences for doing so. There was no coercion of participants at any stage of research work.

Definition of Variables:

Myopia for purposes of this study was defined by the investigators as spherical error of at least -0.50 diopters in one eye.

Table 1.0: Prevalence of myopia among Senior High School students

	Frequency	Percent
Emmetropes	157	50
Myopes	107	34
Hyperopes	51	16
Total	315	100

Out of the 315 students sampled, 107 were suffering from myopia with the prevalence of myopia among the student was 34%. 51 students had hyperopia representing 16% of respondents. Among the students, 157 (50%) did not have any form of refractive error.

Table 1.1: Distribution of refractive error state by stress level of students

		STRESS STATUS		
		No Stress	Stress	
Myopia		45	62	107
Emmetrope		126	31	157
Total		171	93	264

Table 1.2

The chi-square statistic is 45.9262. The p -value is < 0.00001 . The result is significant at $p < .05$.

There was a significant association between childhood stress and myopia ($p < 0.001$). This is with a 95% CI is between 1.8974 to 3.3824. The test result shows a relative risk of 2.5333.

4. DISCUSSION

Our study found out that there is an association between childhood stress and myopia and that stress may be a contributing factor in the development of myopia. Students who suffer significant childhood stress were more likely to suffer from myopia than those who did not suffer from significant childhood stress.

Our findings differ from those of a study done in the United States by Katz (2009) among undergraduate students whereas our students were high school students. The study showed that myopic participants who were undergraduate students reported significantly less childhood stress than emmetropic (normal vision) participants. According to Katz (2009), her findings raises the possibility of differential processing of stressful events between myopes and emmetropes and they state that it is also possible that the differences observed could be attributable to the differences in age groups of the participants of our study compared to those in the United States.

The difference in our results may be partly as a result of different methods used in classifying myopes. Katz (2009) relied on individual complaint to classify myopes and emmetropes. Our research classified myopes using subjective refraction. Difference in findings may also be due to the fact that Katz (2009) sampled undergraduate participants from one institution compared to our study which sampled children from 3 different schools.

It is very clear from our findings that myopia was linked to childhood stress. From the theory of Elias (1989) he is of the opinion that school stress, stressful school environments have been linked to children's experiencing inordinate amounts of fatigue and headaches which can hinder the normal growth of organs and tissues in the body. Balacco-Gabrieli and Tundo (2000) detected significant high level of cortisol in myopes. According to Rosemond (2000), cortisol levels

increases under transient stress and following long-term exposure to stress; however, this is followed by a decrease in the output of cortisol. Cortisol has a high impact on connective tissue by mediating reactions of the immune system, e.g. by decreasing inflammations, and by creating structurally defective connective tissue. (Trichtel and Zur, 1986). High production of cortisol as a result of transient stress in childhood and long term exposure to stress may have therefore decreased cortisol output and had impact on connective tissue which produced long axial length resulting to the development of myopia.

It can therefore be postulated from our study that childhood stress affects the normal growth of the axial length of the eye. This can precipitate the development of myopia. Mild, moderate and severe forms of stress are all associated with the occurrence of myopia. Our findings makes us to infer that mental and emotional states experienced from childhood may influence vision, axial length, refractive power of the eye and the whole process of emmetropization.

5. CONCLUSION

This study concludes that myopia is a significant cause of visual impairment among senior high school students in the Ejisu Juaben District of Ghana, with a prevalence of 34%, and is therefore be an issue of public health concern among senior high school students in the district.

Childhood stress is highly associated with the occurrence of myopia and this study has shown that both the home and school environment can serve as sources of childhood stress which may put an individual at risk. Students who experience significant childhood stress are 3 times more likely to develop myopia compared to children who do not experience significant childhood stress.

6. RECOMMENDATIONS

It is recommended that cost-effective strategies for vision screening of school children be incorporated into the school health program of the Ministry of Health and the Ministry of Education in order to prevent the devastating impact of myopia on student's education and development, then such cost-effective strategies will prove essential.

Counseling services should be strengthened from basic education through to senior high school. Children during the teenage years have many challenges and feel the effects of stress. Times of special changes like divorce, a death in the family, or a move can be stressful. Effective counseling in schools is needed to support parents and guardians to adjust students to stress.

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