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Association of Low Visual Acuity and Head Injury among the Undergraduate Students of Bingham University, Karu, Nigeria

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ABSTRACT

A laboratory-based cross-sectional study was conducted among Bingham University undergraduate students, Karu, to investigate the proportion of visual acuity (VA) among the students. The study aimed at investigating an association between head injury with low VA of students whose parent's use medicated eye glasses. A total of 262 undergraduate students participated in the study. A predesigned, pre-tested, self-administered questionnaire was filled by the students. Eye examination using the optotype Snellen E Chart followed and the VA of the right (VARE) and left eyes (VALE) were tested separately. A regression and correlation model was used to assess the relationship between head injury and low VA. Head injury at one point of time in their life was strongly associated with low VA for both eyes (VARE, r = 0.524, R^2 = 0.274, p = 0.040; VALE, r = 0.0.531, R^2 = 0.282 p = 0.010). Parents' use of medicated eye glasses was also associated with low VA of students (VARE p = 0.009; VALE p < 0.001). Our results showed that students that had any form of head injury at any point in their life either as a child, teenager or an adult, were more likely to have low VA. However, the educational status of parents, anthropometric parameters and ethnicity had no association with low VA. We conclude that any form of head injury, at any point in one's life, and parent's use of eye glasses are risk factors for low VA.

Key words: *Visual Acuity; Head injury; Medicated eye glasses; Bingham University*

INTRODUCTION

Vision is the primary means of integration between the individual and external environment, and knowledge is to a great extent, acquired visually in school learning. Therefore, good vision is a pertinent factor that cannot be disputed (Gianinia et al. 2004). Visual acuity (VA) is an essential measure of visual function (Emerole et al. 2014; Hayes et al. 2019). VA refers to the visual system's ability to resolve, and perceive spatial detail and is the most commonly used measure of visual function in clinical practice (Anstice and Thompson 2014; Bach and Schafer 2016). VA is a composite measure of the capacity for the eye to accurately focus light on the retina, the integrity of the retina, and the brain's ability to interpret the information provided. Acuity (keenness or sharpness) of vision refers to the ability of the eye to recognize two point sources of light, or two parallel lines, as separate rather than one (Cline et al.1997; Silverthorn 2007; Strasburger et al. 2011). Test of VA can provide information about the integrity of the visual system (Anstice and Thompson, 2014). VA is correlated with quality of life measures, such as mobility and the ability of adult patients to live independently (West et al. 1997; Hochberg et al. 2012). A VA test can be done as a diagnostic tool to provide baseline data, as a measure of progression of the disease, as a routine test for employment and school admission purposes, in the acquisition of a license for motor driving and use of ammunition and

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also for research purposes (Emerole et al. 2013, Emerole and Nnel, 2013).

The World Health Organization (WHO) reports that 285 million people are visually impaired worldwide (WHO 2014) with 90% of the visually impaired living in developing countries. Mahdi et al. (2014) reported that about 1.13 million individuals aged 40 years and above are currently blind in Nigeria. A further 2.7 million adults aged 40 years and above are estimated to have moderate visual impairments, and an additional 400,000 adults are severely visually impaired.

When a child is visually impaired and not detected early, it slows their learning process. It results in poor academic performance, which may be because they find it difficult to read their books, or because they cannot see the board clearly (Okoro and Odeyemi 2013; Olatunji et al. 2018). Different investigators have established an association between poor academic performance and impaired vision (Chen et al. 2011; Silva et al. 2013; Kotingo et al. 2014; Park et al. 2016; Olatunji et al. 2018). Routine VA evaluation aims to ensure good visual health, attenuate the high rates of school dropout, academic failure, and preventing several more important visual complications.

A head injury is any injury or trauma to the scalp, skull or brain. It may be a minor bump on the head or a severe brain injury. Head injuries can be caused by falls, home and occupational accidents, motor vehicle traffic collisions, domestic assaults and sports-related accidents (Astrand and Romner 2012; Alberts and Cherian 2014; Snelson et al. 2019). The eye is frequently involved in head trauma due to the proximity of the eye to the head and the neural connections between the eye and the brain. In penetrating brain injury, there may be physical damage to the visual pathway, visual cortex, or other vision-related structures of the brain. In non-penetrating or closed head injury, displacement, stretching, and shearing forces may damage areas of the brain, including those associated with vision. Therefore VA screening for visual problems is essential, as early detection may improve future vision and educational achievement (Mathers et al. 2010).

In Nigeria, for instance, routine eye examinations are not taken seriously and so are rarely conducted, especially in tertiary institutions. VA screening programs are important because they will provide a platform for detecting visual anomalies, and students can then consider ophthalmological evaluation. Previous studies have reported VA screening among primary, secondary or university students in Nigeria (Ideh et al. 2001; Umar et al. 2007; Ayanniyi et al. 2010; Okoro and Odeyemi 2013; Kotingo et al. 2014; Olatunji et al. 2018), but to the best of our knowledge, no study has linked the association between low VA and head injury, be it a fall, domestic accidents, motor vehicle accidents, domestic assaults or sports-related accidents among university students in Nigeria. The study aimed at investigating an association between head injury with low VA of students whose parent's use medicated eye glasses

MATERIALS AND METHODS

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A total of 262 undergraduate students (males n = 105 and females n = 157) aged 17-23 years participated in the study. The study was conducted at Bingham University, Karu. The students were chosen by simple random sampling from five Departments in the Faculties of Basic Medical Sciences, Humanities, Social and Management Sciences, Science and Technology, Health Sciences and Faculty of Law. The study was conducted in the laboratory of the Department of Physiology, where the Snellen chart is housed. Only undergraduate students whether they used medicated eye glasses or not were included in the study; all those who filled the questionnaire but were not available for the laboratory test were excluded from the study. Research and Ethics Committee approved the study (BHU/REC/19/H002). Participants provided informed consent before the commencement of the study.

Questionnaire

The study was based on a questionnaire distributed to the students. A brief description of the test was made to each subject, followed by the consent form and questionnaire. The questionnaire consisted of two sections. A general section concerned with self-reported data of subjects and those of their families, such as the use of medicated eye glasses or contact lens by parents, the involvement of the participant in any head injury caused by a fall, home accidents, motor vehicle accidents, assaults, sports-related accidents and traumatic brain injury at any point of their life and parents level of education among others.

In the other section, standard optotype Snellen's chart values obtained from the subjects were recorded. Values for VA of the right (VARE) and left eyes (VALE) were recorded separately using Snellen's chart (delles trish igrvh). The subjects' VA was measured at a distance of 6 m away from the chart. A flat surface was chosen for this measurement, and Snellen's chart was placed in a vertical position at the student's eye level. The VA for each eye was measured by asking the student to close one eye, while the other was tested. The VA was then expressed as the ratio of the distance of the subject from the chart (d) to the distance at which the letters are typically read (D) which is d/D. In this study, a VA of 6/6 was considered as normal VA (NVA), while a VA of 6/9, 6/12 or worse than 6/12 was considered as low VA (LVA)

Table 1: Participants Characteristics at Baseline

Characteristics	Frequency	Percentage
Sex		
Males	105	40.1
Females	157	59.9
Ethnicity		
Hausa	41	15.6
Igbo	41	15.6
Yoruba	64	24.4
Others	116	44.3
Age (yrs.)		
17 – 19	87	33.2
20 – 22	165	63.0
> 22	10	3.8
Father's level of education		
Illiterate	-	-
Primary school	13	5
Secondary school	27	10.3
Tertiary	222	84.7
Mother's level of education		
Illiterate	-	-
Primary school	16	6.1
Secondary school	19	7.3
Tertiary	227	86.6
Use of glasses		
Yes	58	22.1
No	204	77.9
Head injury		
Yes	63	24.0
No	199	76.0
Parents use of glasses		
Yes	178	67.9
No	84	32.1
VA of the right eye		
Low VA	80	30.5
Normal VA	182	69.5
VA of the left eye		
Low VA	75	28.6
Normal VA	187	71.4
Distribution of VA		
Normal VA	168	64.1
Unilateral VA	33	12.6
Bilateral VA	61	23.3

Statistical Analyses

Descriptive statistics, including means and standard deviations, were calculated for sociodemographic variables. Chi-square and Fisher's exerts tests were used to analyse the risk factors associated with low VA. A regression and correlation model was used to assess the relationship between variables and low VA. Data were analysed using SPSS 25.0 for Windows version 26.0 (IBM Corporation, Armonk, NY, USA). A p-value of less than 0.05 was considered to be statistically significant.

RESULTS

The participant's baseline characteristics are presented in Table 1. 40.1% of the participants were male, and 59.9% were female, out of which 33.2% were between the ages 17-19 years, 63% were between ages 20-22 years, while 3.8% were above 22 years. It was observed that 22.1% of participants used medicated eye glasses, while 77.9% did not. The table also shows that 24% of participants had head injuries either as children or in their teenage age, and 67.9% of participant parents use medicated eye glasses. Low visual acuity (LVA) of the right eye was seen in 30.5% of participants, while 28.6% had LVA in the left eye. Unilateral low VA was observed in 12.6% of participants, while 23.3% had bilateral low VA. Ethnicity, father's and mother's education level are also presented Table 1

Association test and determination factors for low VA

The association between normal, unilateral and bilateral VA of the subjects are presented in Table 2. The use of eye glasses by participants was significantly associated with normal, unilateral and bilateral VA ($\chi2 = 74.22$, $p = 0.001$). There was a significant association between head injury and normal, unilateral, and bilateral VA ($\chi2 = 7.55$, $p = 0.023$). Also, there was a significant association for normal, unilateral, and bilateral VA for participants whose parents use medicated glasses ($\chi2 = 9.47$, $p = 0.009$). However, gender, ethnicity and age had no significant association with normal, unilateral, and bilateral VA.

Multiple regression analysis of factors associated with VA are presented in Table 3. Use of medicated eye glasses by participants, head injury, and parents use of medicated glasses were all determinant factors for LVA of both the left ($r = 0.531$; $R2 = 0.282$, $p = 0.0001$, $p = 0.010$, $p = 0.009$, CI = 95%) and right eyes ($r = 0.524$; $R2 = 0.274$, $p = 0.0001$, $p = 0.040$; $p = 0.001$, CI = 95%). The binary logistic regression analysis of factors associated with low VA of the left and right eyes are shown in Table 5 and 6 respectively. Head injury (left eye $p = 0.013$ and right eye $p = 0.010$) and parent use of medicated glasses (left eye $p = 0.009$ and right eye $p = 0.001$) were determinant risk factors for LVA. Age and gender were not determinant risk factor for LVA ($p > 0.05$).

On the optotype test lines distribution of VA to test for severity of impaired VA, females had lower VA of 6/12, 6/18 and 6/24 (VALE 6.8%, 2.7%, 3.4% and VARE 9.9% and 4.2% respectively) except for VARE test line 6/18 (Table 6).

Table 2: Chi-Square and Fisher's Exact Tests Comparison of Visual Acuity

	Normal	Unilateral	Bilateral		
Variables	n (%)	n (%)	n (%)	χ^2	*P-value*
Sex					
Male	63 (24)	14 (5.3)	28 (10.7)	1.40	0.496
Female	105 (40.1)	19 (7.3)	33 (12.6)		
Use of glasses					
Yes	11 (4.2)	11 (4.2)	36 (13.7)	74.22	**0.001**
No	157 (59.9)	22 (8.4)	25 (9.5)		
Head injury					
Yes	32 (12.2)	13 (5)	18 (6.9)	7.55	**0.023**
No	136 (51.9)	20 (7.6)	43 (16.4)		
Parents use of glasses					
Yes	103 (39.3)	26 (9.9)	49 (18.7)	9.47	**0.009**
No	65 (24.8)	7 (2.7)	12 (4.6)		
Ethnic group					
Hausa	26 (9.9)	5 (1.9)	10 (3.8)	3.63	**0.727**
Igbo	23 (8.8)	6 (2.3)	12 (4.6)		
Yoruba	38 (14.5)	10 (3.8)	16 (6.1)		
Others	81 (30.9)	12 (4.6)	23 (8.8)		
Age group (yrs.)					
17 – 19	57 (21.8)	12 (4.6)	18 (6.9)	2.02	**0.732**
20 – 22	103 (39.3)	20 (7.6)	42 (16)		
> 22	8 (3.1)	1 (0.4)	1 (0.4)		

DISCUSSION

Visual problems have negative effects on learning and social interaction, thus affecting the natural development of intellectual, academic, professional, and social abilities (Thylefors et al. 1984). Visual impairment is the VA of less than 6/6 in the better eye (Fahd et al. 2013) or when the presenting VA is less than 6/6 in the better eye (WHO 2015). In our study, a VA of 6/6 was considered as normal (NVA), while a VA of less than 6/6 was considered as low (LVA). One interesting finding in our study is the relationship between head injury and VA. We categorized head injury as being a mild, moderate or severe hit on the head caused by falls, home accidents, motor vehicle accidents, assaults, sports accidents or traumatic brain injury at any point of their life, either as a child, teenager or as an adult.

When individuals experience any form of head injury to the head, VA testing is usually not part of the routine examination performed. But our results show that subjects who had any form of head injury in their life either as children or adults had low VA of both the right and left eyes. Visual loss following head injury is a common phenomenon (Taber et al. 2006; Atkins et al. 2008; Cockerham et al. 2009). The neuroophthalmic correlation of this effect is that head injuries in many cases may compromise any of the neural pathways that subserve afferent or efferent visual functions. Damage to axons associated with the visual pathway during head injury can lead to axonal injury, which can result into impaired axonal transport and eventually axonal swelling followed by axonal disconnection. Trauma can disrupt vision at any point of the visual pathways, from the retina to the visual centres in the brain. Injury to the optic nerve or cranial nerves III, IV, or VI, either from direct penetration or indirect injury from percussive forces can result in blindness. Injury to the visual processing areas of the brain can result in the loss of both visual acuity and visual field (Levin et al. 1999; Schoth et al. 2006; Steinsapir 2006 and Ueki et al. 2006). Measurement of VA should therefore be given maximum attention after an injury to the head, be it minor, moderate or major injury, as low VA if left untreated may lead to total vision loss later in life.

Our study showed that parents use of medicated eye glasses is significantly associated with LVA in the subjects, both for the right ($p < 0.001$) and the left

Table 3: Multiple Regression Analysis of Factors Associated with Low Visual Acuity

	Intercept	B (95% CI)	SE	*P-value*	r	R^2
Dependent variable: VA of the left eye						
Use of glasses		0.532 (0.42 – 0.65)	**0.057**	**<0.001**		
Head injury	0.041	0.145 (0.03 – 0.26)	**0.056**	**<0.010**	0.531	0.282
Parents use of medicated glasses		0.136 (0.04 – 0.24)	**0.051**	**0.009**		
Dependent variable: VA of the right eye						
Use of glasses		0.529 (0.41 – 0.65)	**0.059**	**<0.001**		
Head injury	0.042	0.102 (0.01 – 0.22)	**0.057**	**0.040**	0.524	0.274
Parents use of medicated glasses		0.179 (0.08 – 0.28)	**0.053**	**<0.001**		

Table 4: Binary Logistic Regression Analysis of Factors Associated with Low Visual Acuity of the Left Eye

	NVA		LVA		Total			
Variables	**n**	**%**	**n**	**%**	**N**	**%**	**Odd Ratio (95% CI)**	***P-value***
Use of glasses								
Yes	34	13	170	64.9	204	77.9	14.497 (7.00 – 30.03)	**<0.001**
No	41	15.6	17	6.5	58	22.1		
Head injury								
Yes	25	39.7	38	60.3	63	24	2.467 (1.21 – 5.02)	**0.013**
No	50	25.1	149	74.9	199	76		
Parents use of medicated glasses								
Yes	59	22.5	119	45.4	178	67.9	2.756 (1.29 – 5.89)	**0.009**
No	16	6.1	68	26	84	32.1		
Age group (yrs.)								
17 – 19	22	8.4	65	24.8	87	33.2		
20 – 22	51	19.5	114	43.5	165	63	0.71 (0.39 – 1.31)	0.272
>22	2	0.8	8	3.1	10	3.8		
Sex								
Female	41	15.6	116	44.3	157	59.9	0.61 (0.32 – 1.18)	0.143
Male	34	13	71	27.1	105	40.1		

eyes (p=0.009). Some studies (Zhang et al. 2006 and Olatunji et al. 2018) have established a relationship between family history of eye diseases and visual defects. Some eye diseases such as, cataract, glaucoma, retinitis pigmentosa, optic atrophy and age-related macular degeneration show a strong genetic susceptibility, they can result from Mendelian inheritance. Glaucoma causes optic nerve damage and can lead to permanent vision loss later in life, with one important risk factor is family history. Along with retinitis pigmentosa, both can be inherited as an autosomal dominant /recessive trait (Mahavir and Suresh 2018). Individuals that present with low VA may indicate eye disease, which is inherited. Therefore, screening of first degree relatives to identify the disease gene/variant and regular eye screening of such individuals is advised. In this study, age was not found to be a determinant risk factor for low VA. The reason being that this study was limited to undergraduate students of ages 17-23 years, and older adults were not involved. But earlier studies have reported that increasing age is a risk factor for

Table 5: Binary Logistic Regression Analysis of Factors Associated with Low Visual Acuity of the Right Eye

	NVA		LVA		Total			
Variables	**N**	**%**	**N**	**%**	**N**	**%**	**Odd Ratio (95% CI)**	***P-value***
Use of glasses								
Yes	42	16	16	6.1	58	22.1	13.898 (6.67-28.95)	**<0.001**
No	38	14.5	166	63.4	204	77.9		
Head injury								
Yes	24	9.2	39	14.9	63	24	2.86 (1.12-3.76)	**<0.010**
No	56	21.4	143	54.6	199	76		
Parent(s) use of medicated glasses								
Yes	65	24.8	113	43.1	178	67.9	3.61 (1.67-7.81)	**<0.001**
No	15	5.7	69	26.3	84	32.1		
Age group (yrs.)								
17-19	26	9.9	61	23.3	87	33.2		
20-22	53	20.2	112	42.7	165	63	1.03 (0.57-1.87)	0.913
>22	1	0.4	9	3.4	10	3.8		
Sex								
Female	44	16.8	113	43.1	157	59.9	0.62 (0.33-1.16)	0.134
Male	36	13.7	69	26.3	105	40.1		

Table 6: Distribution of Visual Acuity Based on the Severity

	V A of the left eye			VA of the right eye		
	Male	Female	Total	Male	Female	Total
Visual Acuity	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
6/12	17 (6.5)	18 (6.8)	35 (13.3)	20 (7.6)	26 (9.9)	46 (17.6)
6/18	2 (0.8)	7 (2.7)	9 (3.5)	5 (1.9)	1 (0.4)	6 (2.3)
6/24	7 (2.7)	9 (3.4)	16 (6.1)	4 (1.5)	11 (4.2)	15 (5.7)
6/6	72 (27.5)	117 (44.7)	189 (72.1)	68 (26)	114 (43.5)	182 (69.5)
6/9	7 (2.7)	6 (2.3)	13 (5)	8 (3.1)	5 (1.9)	13 (5)

low VA (Daffner et al. 2013; Chou et al. 2016; Kong et al. 2016; Xiaochun et al. 2016; Olatunji et al. 2018; Danborno et al. 2020). In the present study, the literacy status of participants' parents did not show any statistical significance with LVA. Olatunji et al. (2018) also reported similar findings. The use of medicated eye glasses by the subjects however had a significant association with low VA; this is expected, as low vision is one reason for the use of medicated eye glasses.

The observations in this study are consistent with earlier studies on the prevalence of LVA which was higher among female subjects for both the left (VALE) and right eyes (VARE) (Ishigaki and Miyao 1994; Abramov et al. 2012; Emerole et al. 2014; Shaqiri et al. 2018). Others have reported that the prevalence of impaired VA is higher among people of lower socioeconomic or educational status (The Eye Diseases Prevalence Research Group 2004; Vitale et al. 2006). Our study did not show this, probably as most of the subjects were almost of the same socioeconomic class.

Conclusion

The present study clearly shows that head injury at any point in one's life, and also, parents use of eye glasses are risk factors for low VA. As such VA testing is warranted, as low VA can negatively impact several areas of the student's well-being. We, therefore, recommend that this type of study should be conducted regularly in our various Universities, especially for new incoming students to make them aware of their VA status, which will help them in choosing seating positions in the classrooms. And also students can then be referred for a complete ophthalmological evaluation.

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Conflict of Interest
None declared.

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Authors Contribution
AMD designed the research work and wrote the final version of the manuscript, IGO carried out the research work and VIE carried out the research work and also wrote the manuscript.

REFERENCES

Abramov, I.G., Feldman, O. and Chavarga, A. (2012) Sex & vision I: spatio-temporal resolution. Biol Sex Differ. 3:1-14.

Alberts, J. and Cherian, N. (2014) Headaches Traumatic Brain Injury, and Concussion. The Cleveland Clinic Manual of Headaches Therapy. Springer International Publishing. Pp. 341-352.

Anstice, N.S. and Thompson, B. (2014) The measurement of VA in children: an evidence-based update. Clin Exp Optom. 97:3-11.

Astrand, R. and Romner, B. (2012) Classification of Head Injury. Management of Severe Traumatic Brain Injury. Springer Berlin Heidelberg. Pp. 11-16.

Atkins, E.J., Newman N.J. and Biousse, V. (2008) Post-traumatic visual loss. Rev Neurol Dis. 5(2):73-81.

Ayanniyi, A.A., Mahmoud, A.O. and Olatunji, F.O. (2010) Causes and prevalence of ocular morbidity among primary school children in Ilorin, Nigeria. Nig J Clin Pract. 13(3):248-253.

Bach, M. and Schafer, K. (2016) VA testing: Feedback affects neither outcome nor reproducibility, but leaves participants happier. PLoS One. 11(1): e0147803.

Chen, A.H., Bleything, W. and Lim, Y.Y. (2011) Relating vision status to academic achievement among year -2 school children in Malaysia. J Am Optom Assoc. 82(5):267-273.

Cline, D., Hofstetter, H.W. and Griffin, J.R. (1997) Dictionary of Visual Science. 4th ed. Boston: Butterworth-Heinemann.

Cockerham, G.C., Goodrich, G.L., Weichel, L.E.D., Orcutt, J.C., Rizzo, J.F., Bower, C.K.S. and Schuchard R.A. (2009) Eye and visual function in traumatic brain injury. JRRD. 46(5):811-818.

Chou, R., Dana, T., Bougatsos, C., Grusing, S. and Blazina, I. (2016) Screening for impaired VA in older adults: Updated evidence report and systemic review for the US Preventive Services Task Force. JAMA. 315(9):915-933.

Daffner, K.R., Haring, A.E., Alperin, B.R., Zhuravleva, T.Y., Mott K.K. and Holcomb, P.J. (2013) The impact of VA on age-related differences in neural markers of early visual processing. Neuroimage. 67:127-136.

Danborno, A.M., Mallo, M.J. and Mamman, T. (2020) Effect of alcohol on visual acuity among commercial drivers in Zaria, Nigeria. IOSR J Dental Med Sci. 19(5):25-29.

Emerole, C.G. and Nneli, R.O. (2013) Visual indices of motor vehicle drivers in relation to road safety in Nigeria. Nig J Physiol. Sci. 28:57-62.

Emerole, C.G., Emerole, C.O. and Nneli, R.O. (2013) Blindness and low vision in Nigeria: A review of etiological factors and impact. J Health Vis Sci. 15(1):10-15.

Emerole, C.G., Nneli, R.O. and Osim, E.E. (2014) Gender and environmental influences on VA in Owerri, Nigeria. Nig J Physiol Sci. 29(1):17-22.

Fahd, A.A., Tarek, T.A., Ayub, A. and Ataur, R.K. (2013) Prevalence and pattern of refractive errors among primary school children in Al Hassa, Saudi Arabia. Global J Health Sci. 5(1):125-135.

Gianinia, R.J., de Masib, E., Coelhob, E.C., Oréficeb, F.R. and de Moraes, R.A. (2004) Prevalence of low VA in public school's students from Brazil. Rev Saude Publica. 38(2).

Hayes, J.F., Picot, S., Osborn, D.P.J., Lewis, G., Dalman, C. and Lundin, A. (2019) VA in late adolescence and future psychosis risk in a cohort of 1 million men. Schizophrenia Bulletin 45(3):571-578.

Hochberg, C., Maul, E., Chan, E.S., Van Landingham, S., Ferrucci, L., Friedman, D.S., et al. (2012) Association of vision loss in glaucoma and age-related macular degeneration with IADL disability. Invest Ophthalmol Vis Sci. 53: 3201–3206.

Ideh, V.C.U., Osahon, A.I., Oseji, M. and Akpan, P. (2001) Vision screening in secondary school children in Benin City. 25th International Congress of International Medical Women's Association.

Ishigaki, H, and Miyao, M. (1994) Implications for dynamic VA with changes in age and sex. Percept Mot Skills. 78:363-369.

Kong, X., Strauss, R.W., Michaelides, M., Cideciyan, A.V., Sahel, J.A., Muñoz, B., et al. (2016) VA loss and associated risk factors in the retrospective progression of Stargardt disease study. Ophthalmology. 123(9):1887-1897.

Kotingo, E.L., Obodo, D.U., Iroka, F.T., Ebeigbe, E. and Amakiri, T. (2014) Effects of reduced VA on academic performance among secondary school students in South-South, Nigeria. Int J Sci Res. 3(4):328-334.

Levin, L.A., Beck, R.W., Joseph, M.P., Seiff, S. and Kraker, R. (1999) The treatment of traumatic neuropathy: The International Optic Nerve Trauma Study. Ophthalmol. 106(7): 106(7):1268-1277.

Mahdi, A.M., Rabiu, M., Gilbert, C., Sivasubramaniam, S., Murthy, G.V., Ezelum, C. et al. (2014) Prevalence and risk factors for lens opacities in Nigeria: results of the national blindness and low vision survey. Invest Opthalmol Vis Sci. 55(4):2642-2651.

Mahavir, S and Suresh, C.T. (2018) Genes and genetics in eye diseases: A genomic medicine approach for investigating hereditary and inflammatory ocular disorders. Int J Ophthalmol 11(1):117-134.

Mathers, M., Keyes, M. and Wright, M. (2010) A review of the evidence on the effectiveness of children's vision screening. Child: Care, Health and Dev. 36(6):756-780.

Okoro, V.A and Odeyemi, K.A. (2013) VA in primary school pupils in Lagos, Nigeria. J Comm Med Pri Health Care. 25(1):51-57.

Olatunji, L.K., Oche, M.O., Adamu, H., Mohammad, A., Abdusalam B. and Tahir, Y. (2018) Visual impairment and its relationship to academic performance among primary school children in Sokoto metropolis, North-Western Nigeria. Inter J Recent Adv Multidisciplin Res. 5(4):3770-3774.

Park, A., Glewwe, P. and Zhao, M. (2016) A better vision for development: Eyeglasses and academic performance in rural primary schools in China. HKUST IEMS Working Paper Series 2016-37, HKUST Institute for Emerging Market Studies.

Schoth, F., Burge, I.U., Dorsch, R., Reinges, M.H. and Krings, T. (2006) Diffusion tensor imaging in acquired blind humans. Neurosci Lett. 398(3):178-182.

Shaqiri, A., Roinishvili, M., Grzeczkowski, L.., Chkonia, E., Pilz, K.., Mohr, C., et al. (2018) Sex-related differences in vision are heterogeneous. Scientific Reports. 8:7521 doi:10.1038/s41598-018-25298-8

Silva, C.M., Almeida, D.R., Bernardes, R.R., Bazzano, F.C., Mesquita Filho, M., Magalhães, C.H. (2013) Desempenho escolar: interferência daacuidade visual. Rev Bras Oftalmol. 72(3):168-171.

Silverthorn, D.U. (2007) Human physiology. An integrated approach. 4th edn. Pearson Education, San Francisco, CA. Pp 366.

Snelson, E., King D., Rominiyi, O. and Hardman, S. (2019) Is cranial tomography unnecessary in children with a head injury and isolated vomiting. BMJ. 365:11875.

Steinsapir, K.D. (2006) Treatment of traumatic optic neuropathy with high-dose corticosteroid. J Neuroophthalmol. 26(1):65-67.

Strasburger, H., Rentschler, I. and Juttner, M. (2011) Peripheral vision and pattern recognition. J. Vis. 11(5):3. doi: 10.1167/11.5.13.

Taber, K.H., Warden, D.L. and Hurley, R.A. (2006) Blast-related traumatic brain injury: What is known? J Neuropsychiatry Clin Neurosci. 18(2):141-145.

The Eye Diseases Prevalence Research Group (2004) The prevalence of refractive errors among adults in the United States, Western Europe, and Australia. Arch Ophthalmol. 122(4):495-505.

Thylefors, B., Ruiz, L., Cardoso, M.D.P.S., Romero, L.C. and Barros, O.M. (1984) Proposta de um plano nacional de saúde ocular, com ênfase na atenção primária. Arq Bras Oftalmol. 47:2-6.

Ueki, S., Fujii, Y., Matsuzawa, H., Takagi, M., Abe, H., Kwee, I.L., et al. (2006) Assessment of axonal degeneration along thehuman visual pathway using diffusion traceanalysis. Am J Ophthalmol.142(4):591-596.

Umar, F., Ibrahim, M. and Hassan, R. (2007) VA and academic performance of primary school children in Sokoto, Nigeria. Nig Sch Health J. 18: 51-57.

Vitale, S., Cotch, M. F. and Sperduto, R. D. (2006) Prevalence of visual impairment in the United States. JAMA. 295:2158-2163.

West, S.K., Munoz, B., Rubin, G.S., Schein, O.D., Bandeen-Roche, K., Zeger, S., German, S. et al. (1997) Function and visual impairment in a population-based study of older adults. The SEE project. Salisbury Eye Evaluation. Invest Ophthalmol Vis Sci. 38:72-82.

WHO (2014). Visual impairment and blindness. Fact Sheet N 282. World Health Organisation http://www.who.int/mediacentre/fact sheets/fs282/en/

WHO (2015). Change the Definition of Blindness. World Health Organisation https://www.who.int/blindness/Change%20the%20Definition%20of%20Blindness.pdf

Xiaochun, L., Xiaoguang, C., Xianru, H. and Yongzhen, B. (2016) The correlation of age and postoperative VA for age-related cataract. BioMed Res Int. 7147543. https://dx.doi.org/10.1155/2016/7147543.

Zhang, Q., Guo, X., Jia, X., Li, S. and Hejtmancik, J.F. (2006) Novel locus for x-linked recessive high myopia maps to xq23-q25 but outside MYP1. J Med Genet. 43(5):e20.

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