Original Article

Astigmatism: Prevalence, Distribution and Determinants in Owerri, Nigeria

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Abstract

Background: Astigmatism impairs focusing ability of the eyes at far and near distances. This causes distortion, blurred vision, eye strain, headache, makes difficult visual tasks such as reading, driving (especially at night), focusing on the classroom board and computer screen. This study determined the prevalence, distribution and determinants of astigmatism in Owerri, Imo State, Nigeria in order to establish a baseline data for the state. **Materials and Methods:** Three thousand, four hundred and fifty – one adults consisting of 2606 persons as test subjects and 845 persons as controls were randomly selected for the study. Structured – questionnaire was administered to the subjects and thereafter, the visual acuity at far and near including tonometry, ophthalmoscopy, perimetry, retinoscopy and subjective refraction were done. Astigmatic correction was prescribed in the minus cylinder format and astigmatism was defined as a cylindrical error less than -0.50 diopter cylinder in any axis. Astigmatism was classified by axis as with-the-rule (WTR), against-the-rule, and oblique astigmatism. **Results:** A prevalence of 20.9% and 22.5% of astigmatism was found in the study and control groups respectively. From the astigmatics, 59.4% and 61.1% of females in the study and control groups respectively (especially females aged 40-49) were mostly affected. WTR astigmatism of ≤1.00DC (P = 0.000) was statistically significant between study and control groups. A higher prevalence of astigmatism was found in subjects domiciled in the rural areas and caused by factors like environmental influences, poor nutrition and irrational first line drug use of chloroquine. **Conclusion:** To achieve the targets of vision 2020, we recommend periodic visual examination and health education on diet, drug use and safe environmental practises especially for people living in rural areas in low income economy like ours.

Key words: Astigmatism, ametropia, blurred vision, visual impairment, with-the-rule

INTRODUCTION

The eye is optically equivalent to the usual photographic camera. The human eye has a lens system, a variable aperture system (the pupil) and a retina that corresponds to the film. Visual perception is the physiologic function of the human eye (Ganong, 2011; Guyton and Hall, 2003). Refractive errors are categorized as spherical or cylindrical. There are three basic types of refractive errors: astigmatism, hyperopia and myopia (Borish, 1975). The cornea is one of the components of ocular refraction. The cornea is the clear front window of the eye. A normal cornea is round and smooth, like a basketball. In astigmatism, the cornea curves more in one direction than in the other, like a football (Baldwin and Mill, 1981; Borish, 1975). Astigmatism is the main visual problem caused by pterygium. Clear and effortless vision is a necessity and impacts on quality of life, productivity and socio-economic development especially in low-income economy like ours.

Astigmatism usually is caused by an irregularly shaped cornea, with one meridian being significantly more curved

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than the meridian perpendicular to it. In some cases, astigmatism is caused by the shape of the lens inside the eye. This type of astigmatism is called lenticular astigmatism to differentiate it from the more common corneal astigmatism. The axis of astigmatism in eye glass and contact lens prescription describes the location of the flatter principal meridian of the eye (Garber and Hughes, 1983; McKendrick and Brennan, 1996).

Astigmatism can be classified as total astigmatism (physiologic i.e. anterior corneal plus residual astigmatism); corneal astigmatism (with the-rule/direct, against-the rule/inverse or oblique); by degree (as low, medium or high); symmetric/asymmetric astigmatism (when referred to both cornea); irregular astigmatism (e.g. conical cornea); lenticular astigmatism; hyperopic astigmatism; myopic astigmatism; mixed astigmatism etc., Astigmatic correction is prescribed in the minus cylinder format (Goss and Cox, 1985; Gudmundsdottir *et al*., 2000). Eyeglasses (with cylindrical lenses) are used in correcting astigmatism. Contact lenses (toric lenses) and surgery (astigmatic keratotomy [AK]; photorefractive keratectomy [PRK] and laser *in situ* keratomileusis [LASIK]) are options in management of astigmatism (Alio *et al*., 2002; Alio *et al*., 2004).

Astigmatism is the most widely prevalent refractive error that presents for correction (Borish, 1975). Inflammatory or degenerative processes (including opacities), pterygia or healing of wounds may cause irregular astigmatism (Borish, 1975; Emerole, 1992; Emerole, 2006).

It is interesting to note that –0.50DC of against-the-rule (ATR) astigmatism produces more asthenopia than 1.00DC of with-the-rule (WTR) astigmatism (Borish, 1975; Dandona, 1999; Emerole *et al*., 2011; Ingram *et al*., 2000; Poe, 1997).

The price of uncorrected astigmatism is as follows: blurry vision; asthenopia (astigmatism is one of the major causes of asthenopia); eye strain (especially with reading or other prolonged visual tasks); frontal and temporal headache (basal headache in monocular astigmatism) and tearing (Borish, 1975). Squinting is a very common symptom of uncorrected astigmatism. It is not uncommon to observe constricted pupil to reduce aberration; narrowed palpebral fissure to secure stenopaic slit effect; constricted brow/wrinkling and furrowing of the brows; and assumption of unnatural ocular postures in cases of oblique astigmia in persons who are astigmatic (Borish, 1975; Dandona, 1999).

Consequently, uncorrected astigmatism has been found to limit educational pursuits (Holden, 2007). In 2007, the Nigerian Optometric Association in making their National action plan for Vision 2020 observed that there was no data on refractive errors and low vision in Nigeria. This study therefore was undertaken to provide epidemiologic data as a basis for appropriate intervention.

MATERIALS AND METHODS

A total number of 3451 subjects (made up of 2606 in the test group) were recruited between September 2007 and November 2009 from persons living in old Owerri province, Imo State, Nigeria. The controls (845) were selected from persons living in Ihiagwa autonomous community in Owerri West local government area using a multistage random sampling. The controls were persons who did not present any eye defects on examination protocol. Only those above 18 years (aged 20–69 years) were selected for the study.

Interviewer administered Structured questionnaires that were used to determine demographic characteristics, dietary habits, alcohol consumption, tobacco use; and history of past ocular and systemic problems of subjects was also obtained.

Those with conditions interfering with accurate ocular refraction such as corneal opacity; visually impairing opaque media; diabetes mellitus; hypertension; pseudophakic and aphakics were excluded from analysis. All the subjects underwent a complete ophthalmic examination with the use of standard procedures which included measurement of distant, near and pin-hole visual acuity in subjects with visual acuity less than 6/6 (with Snellen's chart and near reading charts); tonometry (tonometric values of 9–24 mmHg were taken as normal while tonometric values >24 mmHg were considered clinically significant); ophthalmoscopy (internal eye examination was done with the direct ophthalmoscope); retinoscopy (refractive status was determined objectively with the streak retinoscope, trial frame and trial lenses); subjective refraction and perimetry to investigate other possible causes of impairment or reduction in vision. Ocular measurements were conducted on the study and control groups with same protocol. Refractive errors (ametropia) were defined. Astigmatism correction was prescribed in the minus cylinder format and astigmatism was defined as a cylindrical error less than –0.50diopter cylinder(<–0.50DC) in any axis. Astigmatism was classified as WTR if the axis lay between 15^0 on either side of the horizontal meridian, ATR, if the axis lay between 15^0 on either side of the vertical meridian and oblique, if the axis lay between 15^0 and 75^0 or between 105^0 and 165^0. There was high correlation between degree of myopia in right and left eyes (i.e. fellow eyes) of subjects ($P < 0.001$) and because the results based on right eye and left eye were similar, data for right eyes only

were reported, except in the analysis of anisometropia. Refraction data are based on subjective refraction. Results analysis was done using EPI Info version 3.5, (2008) statistical data package. Ethical approval for the study was obtained from Ethical committee of College of Medicine and Health Sciences, Abia State University, Uturu; and consent was obtained from the subjects.

RESULTS

The prevalence of astigmatism in the study group was 20.9% and in the control 22.5%. Majority of the subjects (79.5% and 76.1% of study and control groups, respectively) had ametropia. The differences between the study and control groups were not statistically different as shown in Tables 1 and 2.

Of the subjects in this study who were found to be astigmatic, 59.4% and 61.1% females in the study and control groups respectively (especially females aged 40-49) were in the majority. The mean age of subjects in this study was 44.5 years. The differences between the two groups in the proportion of male and female subjects with respect to astigmatism were statistically significant as shown in Table 3.

Sixty-one per cent of subjects in both study and control groups were rural dwellers (Emerole *et al*., 2011). About 41.8% and 30.8% of study and control groups respectively had tertiary education. Students (22.9%) were in the majority in the study group while skilled persons (21.5%) were in the majority in the control group (Emerole *et al*., 2011).

AMETROPIA AND RISK FACTORS AFFECTING VISION

It was observed that in 67.6% and 49.2% of ametropics in the study and control groups respectively chloroquine was the regular antimalarial drug. In the study group, 62.2%, and control group, 31.6%, were in the habit of consuming food items of low nutritional value. About 33.6% and 27.4% of ametropics in the study and control groups respectively consumed alcohol, while 19.9% and 15.1% in the study and control groups respectively used tobacco (Emerole *et al*., 2011).

DISCUSSION

A prevalence of 20.9% and 22.5% of astigmatism was found in the study and control groups respectively in this study. A prevalence of 27.4% of astigmatism was found in the pilot study among patients attending the eye clinic of the University of Nigeria Teaching Hospital,

Table 1: Prevalence of astigmatism in subjects

Refractive status	Study group *n*=2606		Control group *n*=845		P value
	No.	%	No.	%	
Astigmatic	545	20.9	190	22.5	0.73
Non-astigmatic	2061	79.1	655	77.5	0.73

Table 2: Refractive status of subjects

Refractive status	Study group *n*=2606		Control group *n*=845		P value
	No.	%	No.	%	
Hyperopia	917	35.2	293	34.7	1.00
Myopia	610	23.4	166	19.6	0.60
Astigmatism	545	20.9	190	22.5	0.73
Emmetropia	534	20.5	196	23.2	0.73

Table 3: Astigmatism by age and gender

Age (years)	Male				Female				*P* value
	Study group *n* = 221		Control group *n* = 74		Study group *n* = 324		Control group *n* = 116		
	No.	%	No.	%	No.	%	No.	%	
20–29	38	17.2	6	8.1	106	32.7	27	23.3	0.00*
30–39	39	17.6	10	13.5	38	11.7	18	15.5	0.23*
40–49	64	29.0	37	50.0	148	45.7	64	55.2	0.01*
50–59	54	24.4	16	21.6	28	8.6	5	4.3	0.00*
60–69	26	11.8	5	6.8	4	1.2	2	1.7	0.00*

Enugu (Nworah and Ezepue, 1992). The studies done in Sumatra Indonesia and India (APEDS) showed a prevalence of 18.5% and 12.9% astigmatism (Raju *et al*., 2004). The prevalence of refractive error varies according to population characteristics, such as age and ethnic group (Ching *et al*., 2003). Other factors such as genetic and environmental influences (near work, night lighting and the UV exposure) are also believed to play a role in determining the refractive status of the eye. These may explain the variation in the prevalence of astigmatism in this study in comparison with the studies done in Sumatra Indonesia and APEDS (Raju *et al*., 2004). Karoye-Egbe *et al* (2010) found uncorrected astigmatism to be the most common refractive error in Bayelsa State, Nigeria. Prevalence estimates depend on the definition of the disease or disorder, study population and measurement method. Lack of standard definitions makes comparison difficult, a problem that is rampant in refractive error research (Karoye-Egbe *et al*., 2010; Pensyl *et al*., 1997; Raju *et al*., 2004; The Eye Diseases Preventive Research Group, 2004).

Of the subjects in this study who were found to be astigmatic, 59.4% and 61.1% of females in the study and control groups respectively (especially females aged 40-49) were in the majority. The higher prevalence of

astigmatism in females than males may be due to the fact that the female genders were more in number in this study. Also motherhood and female gender roles in the family and community in the area of domestic chores and peasant farming make more demand on women's vision. The discovery of an association of the female gender with ametropia has been replicated elsewhere (Nworah and Ezepue, 1992) but Karoye-Egbe found a higher prevalence of astigmatism among the male gender in a similar study in Bayelsa State Nigeria (Karoye-Egbe *et al*., 2010).

In the present study, a higher prevalence of astigmatism was found among rural dwellers. There was no significant interaction between occupation and astigmatism. The literacy level was higher in the study group. Visual demands from reading and writing in addition to discomfort from astigmatism may be why they sought intervention.

Astigmatism of ≤ 1.00DC was found in 96.1% and 98.4% of the study and control groups, respectively. The range of astigmatic refractive power was –0.25DC to 3.50DC. Hyperopic and myopic astigmatism was found in some of the subjects. Simple astigmatism was in the majority (93.9% and 91.5% of the study and control groups, respectively). The higher prevalence of astigmatism of ≤ 1.00DC and simple astigmatism in this study may be due to the fact that the subjects with conditions interfering with accurate ocular refraction were excluded in this study. Of subjects in this study with astigmatism, 71.7% and 74.7% of study and control groups were WTR astigmatism while 27.2% and 25.3% of study and control groups respectively were ATR and 1.1% of subjects in the study group had oblique astigmatism. Oblique astigmatism was not present in the control group. Conical cornea was not found in the study and control groups in the present study. The absence of conical cornea in this study may be because of the exclusion criteria Table 4.

Few distribution curves of astigmatism have been published. The most common type of astigmatism in this study is WTR astigmatism (71.7% and 74.7% of study and control groups respectively had WTR astigmatism). Astigmatism showed a higher concurrence with myopia than hyperopia in this study Tables 5 and 6.

The role of nutrition and drug on health and disease is equally noted (Emerole, 2006; Emerole *et al*., 2011; Ganong, 2011; Guyton and Hall, 2003). Majority of ametropics in this study were in the habit of consuming food items of low nutritional value and used chloroquine as the first-line drug for malaria (Emerole *et al*., 2011). Malaria is endemic in Nigeria. Abuse of chloroquine affects components of refraction and vision especially in the absence of adequate nutrition (Borish, 1975). Thirty-three percent and 27.4% of subjects in the study and control groups respectively consumed alcohol. Although more subjects in the study group than in the control group consumed alcohol, the differences between the groups was not statistically significant. In a similar study among an elderly Chinese population in Taiwan (the Shihpai eye study), about 11.7% of the persons in the study were current alcohol drinkers. Just as in the present study, alcohol intake did not significantly affect the prevalence of astigmatism (Ching *et al*., 2003).

In the present study, 19.9% and 15.1% of the study and control groups respectively were indulged in tobacco. There was no statistically significant difference in tobacco use between the study and control groups. Tobacco use by some of the subjects in this study did not significantly affect the prevalence of astigmatism (Emerole *et al*., 2011). In the Shihpai eye study, 17.6% of the participants were current smokers (Ching *et al*., 2003). Comparable literature on distribution and determinants of astigmatism are difficult to come by from the few studies on refraction in Africa (Nworah and Ezepue, 1992).

CONCLUSION

The level of prevalence of astigmatism in Owerri, Nigeria, was high compared with the levels in the high and medium income resource countries like the United States of America, China and Singapore. The reason for this marked difference may be due to the identified poor level of nutrition, frequent use of quinine as antimalarial and environmental influences.

RECOMMENDATION

Regular vision screening and health education on diet, drug use and safe environmental practices should be incorporated as one of the priorities under the disease control component of the Global initiative for elimination

Table 4: Astigmatism by magnitude

Magnitude of astigmatism	Study group *n*=545		Control group *n*=190		*P* value
	No.	%	No.	%	
≤1.00D.Cyl	524	96.1	187	98.4	0.40
>1.00D.Cyl to 2.00D. Cyl	21	3.9	3	1.6	0.40

Table 5: Types of astigmatism (simple or mixed astigmatism)

Type	Study group *n* = 545		Control group *n* = 190		*P* value
	No.	%	No.	%	
Hyperopic astigmatism	8	1.5	2	1.1	0.56
Myopic astigmatism	25	4.6	14	7.4	0.55
Simple astigmatism	512	93.9	174	91.5	0.58

Table 6: Classification of astigmatism by axis: WTR, ATR, oblique, etc

Type	Study group *n*=545		Control group *n*=190		*P* value
	No.	%	No.	%	
With-the-rule astigmatism	391	71.7	142	74.7	0.63
Against-the-rule astigmatism	148	27.2	48	25.3	0.75
Oblique astigmatism	6	1.1			-
Conical Cornea					

WTR - With-the-rule, ATR - Against-the-rule

of avoidable blindness.

REFERENCES

1. Alio J., Salem T., Artola A., Osmon A. (2002). Intra corneal rings to correct corneal ectasia after laser *in situ* keratomileusis. J Cataract Refract Surg 28: 1568-74.
2. Alio J.L., Artola A., Ruiz-Moreno J.M., Hassaneim A., Galal A., Awadalla M.A. (2004). Changes in keratonic cornea after intra corneal ring segment expalanation and reimplantation. J. Cataract Refract Surg 111: 747-51.
3. Baldwin W.R., Mills D. (1981). A longitudinal study of corneal astigmatism and total astigmatism. Am J Opton Physiol Opt 58: 206-11.
4. Borish I.M. (1975). Clinical Refraction (3rd ed). The Professional Press, Inc. Chicago, Illinois. p. 5-694.
5. Ching C.Y., Hsu W.M., Liu J.H., Tsai S.Y., Chou P. (2003). Refractive errors in an elderly Chinese population in Taiwan: The Shihpai Eye Study. Invest Ophthalmol Vis Sci 44: 4630-8.
6. Dandona L., Dandona R., Naduvilath T.J., McCarty C.A., Srinivas M., Mandal P., *et al*. (1999). Burden of moderate visual impairment in an urban population in Southern India. Ophthalmology 106: 487-504.
7. Emerole C.G. (1992). The influence of environmental factors on the occurrence of allergic conjunctivitis amongst primary school pupils in Owerri, urban. Doctor of Optometry (O. D) Dissertation. Abia State University, Uturu.
8. Emerole C.G, (2006). Visual indices of commercial motor vehicle drivers in relation to road safety in Nigeria. Seminar paper on the pilot survey on the visual profile of motor vehicle drivers in Owerri Municipal, presented at the Abia State University, Uturu.
9. Emerole C.G., Nneli R.O., Osim E.E., Anyaehie U.B., Okereke Chiamaka (2011). Prevalence, Determinants and Distribution of Refractive errors in a Nigerian community. J Biosci Biotechnol Res Asia 8 (2): 523-8.
10. Ganong W.F. (2011). Review of Medical Physiology 21st ed. The McGraw Hill Companies Inc. USA. p. 150-5; 168-70.
11. Garber J.M., Hughes J. (1993). High Corneal astigmatism in Adult Navajo Population. J Am Optom Assoc 54: 815-8.
12. Goss D.A., Cox V.D. (1985). Trends in the change of clinical refractive error in Myopia. J Am Optom Assoc 56: 608-13.
13. Gudmundsdottir E., Johnson F., Johnson V., Stefansson F., Sasaki H., Sasaki K. (2000). With-the-rule astigmatism is not the rule in the elderly: Reykjavik Eye study- a population based study of refraction and visual acuity in citizens of Reykjavik 50 years and older. Iceland-Japan. Co-working study groups. Acta Ophthalmol Scand 112: 672-7.
14. Guyton A.C., Hall J.E. (2003). Textbook of Medical Physiology 10th ed. Elsevir, New Delhi, India. p. 566-800.
15. Holden A.B. (2007). Uncorrected refractive error: The major and most easily avoidable cause of vision loss. Community Eye Health J 20: 37-9.
16. Ingram R.M., Gill L.E., Lambert T.W. (2000). Effect of Spectacles and changes of spherical hypermetropia in infants who did and did not have strabismus. Br J Ophthalmol 84: 324-6.
17. Karoye-Egbe A., Overensi-Ogbomo G.O., Adio A.O. (2010). Refractive error status in Bayelsa State, Nigeria. J Niger Optom Assoc 16: 11-6.
18. Mckendrick A.M., Brennan N.A. (1996). Distribution of Astigmatism in the adult population. J Opt Soc Am A Opt Image Sci Vis 13: 206-14.
19. Nigerian Optometric Association (2007): Nigerian Optometric Associations Report on the strategic action plan for vision 2020: The right to sight for Nigeria, 2007-2011.
20. Nworah P.B., Ezepue U.F. (1992). Prevalence of errors of refraction in a Nigerian Eye Clinic. Orient J Med 4: 57-60.
21. Pensyl C.D., Harrison R.A., Simpson P., Waterbar J.W. (1997). Distribution of astigmatism among Sioux Indians in South Dakotta. J Am Optom Assoc 68: 425-31.
22. Poe G.S. (1984). Eye care visits and use of Eye glasses or contact lenses, United States, 1979 and 1980. Vital Health Stat. 10. Hyattsville. M. D: National Centre for Health Statistics; No. 145.
23. Raju P., VeRamesh S., Arvind H., George R., Baskaran M., Paul P.G., *et al*. (2004). Prevalence of Refractive errors in a Rural South Indian Population. Invest Ophthalmol Vis Sci 45: 4268-71.
24. The Eye diseases Prevalence Research Groups (2004). Prevalence of refractive errors among adults in the United States, Western Europe and Australia. Arch Opthalmol 122: 495-505.

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