IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 2 Ser.11 (February. 2023), PP 07-13
www.iosrjournals.org

Pattern of Refractive Error in Eleme Local Government Area, River State, Nigeria

Henry-Ndubuka, C. E[1]., Onua, A.A[2]*. Chukwuka, I.O[2].
[1]*NNPC Medical Services Limited (NMSL), Port Harcourt, Nigeria*
[2]*Department of Ophthalmology, University of Port Harcourt, Nigeria*
Corresponding Author:
Azubuike Alfred Onua; Department of Ophthalmology, University of Port Harcourt, Nigeria

Abstract
Background: *Uncorrected refractive error is one of the common causes of vision impairment worldwide and could pose a great challenge in the realization of vision 2020 especially in the developing world and communities with poor resource setting. Socio-economic lives of affected individuals could be negatively affected. Aim: The aim of this study was to identify the pattern of refractive error in Eleme Local Government Area of Rivers State, Nigeria* ***Method:*** *This was a population-based descriptive cross-sectional study. A total of 362 individuals voluntarily participated. Participants' demographic data, detailed ocular examination, objective and subjective refractions were carried out and data inputted into SPPS version 25 for analyses. Statistical significance was set at p≤0.05.* ***Results:*** *Astigmatism was the most prevalent refractive error significantly (87.3%), followed by presbyopia (76.8%), hyperopia (73.2%) and myopia (20.4%) in the study population. Some participants had more than one type of refractive error. More females had myopia (55.4%) and hyperopia (51.7%) than males.* ***Conclusion:*** *Uncorrected refractive error is a significant contributor to avoidable blindness. The prevalence of myopia, hypermetropia, astigmatism and presbyopia are high among the people of Eleme Local Government Area. Vision and quality of life can improve through appropriate optical care and affordable eye glasses.*

Keywords: *Eleme Local Government Area, Pattern, Refractive Error*

Date of Submission: 05-02-2023 Date of Acceptance: 17-02-2023

I. Introduction

Refractive error prevalencediffers greatly across geographic, racial, age, and ethnic lines, which has a substantial impact on the strategies used to treat refractive error that is not corrected[1] This is especially true in under developed and developing nations, where the resources are limited to target specific groups who are the most affected, for instance, the poor who live in underserved areas with inadequate basic services for eye care and facilities. Furthermore, socioeconomic status has an impact on the capacity to obtain correction for refractive error [2]. Refractive errorsthat are not corrected impair or reduce millions of people's lifestyle qualityaround the world, regardless of their sex, age, or race [3].

The International Classification of Diseases, 10th revision defines refractive error as a defect in the focusing of light on the retina that causes blurred vision [4]. Uncorrected refractive error is a common cause of vision impairment and a major factor in blindness worldwide [5]. According to estimates, more than 2.3 billion people worldwide suffer from refractive error [6].Optical correction techniques such as spectacles and contact lenses, in addition to refractive surgical procedures, may correct refractive error [7].

It is estimated that 670 million individuals globally have need ofeye glasses; 517 million individuals have close vision impairment and 153 million individuals have far vision impairment [8].It was also estimated that 410 million of the 517 million persons who do not wear spectacles for near vision correction are not able to conduct near vision tasks and activities [8]. Refractive errors that are not corrected account for up to 42% of all cases of visual disability worldwide [9].

The corneal surface is the main contributor to the human eye's optical system, responsible for almost 75% of the eye's refractive power [10]. The remaining refractive power is supplied by the crystalline lens. Additional power is supplied by the lens during accommodation.

Emmetropia is the term used to describe the eye's "normal" refractive condition [11]. A relaxed accommodation state in an emmetropic eye causes parallel rays of light to sharply focus on the retina. If the accommodative amplitude is adequate, an emmetropic individual should have good vision (6/6 or better) at a 6-meter distance and equally good vision at nearwithin a distance of 40 centimeters.In an ametropiceye, parallel rays of light do not converge to a clearpoint of focus on the retina with accommodation relaxed [11].

According to current data, over 90 percent of individuals who have untreated refractive error reside in remote settings and low-income nations around the world [12]. In Nigeria, refractive error accounts for 77.9 percent mild visual impairment, 57.1 percent moderate visual disability, as well as 11.3 percent severe visual disability in [13]. This work is focused to review the pattern of refractive error in Eleme Local Government Area of Rivers State, Nigeria (an oil-rich rural setting).

II. Materials and Methods

Study Design: This was a descriptive cross-sectional population study.

Study Area: The study was carried out in Eleme Local Government Area of Rivers State, Nigeria comprising of: the Nchia group –Alesa, Aleto,Alode, Akpajo,Agbonchia and Ogale, as well as the Odido group - Ebubu,Ekporo, Eteo and Onne.

Inclusion Criteria

Individuals who have impaired vision.

Exclusion criteria: Individuals whose impaired vision is not because of refractive error.

Study Tools

- Visual acuity (VA) chart (Snellen chart): Snellen chart was utilized to measure the distance vision.
- Near chart: For testing near vision.
- Eye occluder: Subjective refraction and eye examination were done monocularly, the eye occluder was utilized to occlude one eye while the other was tested.
- Pen torch: The examination of the external parts of the eye was done using the pen torch.
- Keeler ophthalmoscope: This was for examining the internal parts of the eye.
- Keeler retinoscope: The retinoscope was for objective refraction.
- Trial frame: It is an adjustable frame used during refraction to hold lenses.
- Trial lenses: These were utilized for both subjective refraction and objective refraction.
- Chair: For the participants' comfort.

Sample Size Determination

Sample size was computed utilizing Cochran sample size formula $n = (z^2pq)/d^2$[14].

$n = (z^2pq)/d^2$

n = sample size

z = 1.96 standard normal deviation which corresponds to 95% confidence level

p = 28.5% based on earlier studies on refractive error prevalence [15].

q = 1-p which is probability of an event not occurring

d = 0.05 desired level of precision

$n = (1.96)^2 \times 0.285 \times (1-0.285)/ (0.05)^2$

n = (3.8416 x 0.285 x 0.715)/ 0.0025

n = 313.128816

n = 313

An adjustment was made for non-response rate of 10%

Total sample size = n/ (1-non-response rate)

= n/ (1-10%)

= n/ (1-0.1)

= 313/0.9

Minimum Sample Size = 348

Sampling Technique

Multistage sampling technique was employed in this study

First stage

Six (6) wards out of the 10 wards in Eleme Local Government Area were chosen at random via Win Pepi computer soft wear.

Second stage

A list of the villages in each selected ward was obtained and two villages were chosen at random per ward.Participants gathered at selected venue within the community for eye examination.

Data Collection

Participant's demographic data wereobtained which included:sex,occupationand age.

Detailed history was taken and comprehensive eye test wascarried out on each participant. The eye test included; visual acuity(VA) measurement, examination of external part of the eyes, fundoscopy, retinoscopy and subjective refraction.

Visual acuity measurement

Visual acuity test wasdone under bright illumination with Snellen's chart at 6meters. For participants that wereunable to read the chart at 6 meters, the chart was moved closer until the participantwas capable of reading the top letter. The distance where the participant read the top letter was noted and documented. Participant that was incapable ofreading the Snellen's chart at 1m was asked to count the examiner's fingers(CF) or hand motion (HM) or Light perception as the case may be. Where the participant could not perceive light, VA was recorded as no perception of light (VA = NPL).

Visual acuity was evaluated at near, at a distance of 40 centimeters. The smallest paragraph, participant was able to read was noted and documented as near VA.

Examination of the external part of the eyes

The external part of the eye alongside its structures for each individual was examined for abnormalities. This wasdone using the pen torch. The areas examined included; eyelid, eye lashes, the conjunctiva, the anterior chamber (AC), the cornea, the pupil, and the iris. Any abnormalities in size, shape, colour or general appearance was noted.

Fundoscopy

Direct ophthalmoscopy was done under dim illumination using Keeler ophthalmoscope. Each participant sat comfortably on a chair and focused on a target straight ahead. To examine the participant's right eye, the ophthalmoscope was held using the right hand and also using the right eye to view the fundus of the retina. The ophthalmoscope was held 15 centimeters from the eyes and in a rightward 15-degree from the participant. The cup to disc ratio wasestimated, vessels, macular and the retinal background wereexamined for abnormalities. This procedure was repeated for the participant's left eye, using the left eye while the ophthalmoscope was held with the left hand.

Retinoscopy

Retinoscopy was alsoconducted under dim illumination. The participant sat comfortably on thechair and fixated on a distant target (preferably the biggest letter on the Snellen's chart). This helped to relax accommodation. Cycloplegic agents was instilled into the eye when necessary (especially in children) to relax accommodation. The participant sat at arm's length from the examiner. Starting with the right eye, the retinoscope streak was shone into the participant's eye and moved from side to side. The streak was moved in different meridian to determine the movement of the light reflex. If the motion of light reflex was "with" motion, plus lenses were added until there was no more movement. This was neutrality. If the motion of light reflex was "against" motion, minus lenses were added until there was no more movement. In the existence of astigmatism, light beam was rotated until it was parallel with the reflex movement. Minus or plus lenses were then added to neutralize the "against" or "with" movement. The same procedure wasdone for the left eye. The final lens diopter used in achieving neutrality was observed and the working distance in diopter was subtracted from it.

Subjective refraction

This test was needed to get the best attainable visual acuity. Retinoscopic findings were used as the beginning of subjective refraction.Subjective refraction like the objective refraction (retinoscopy) was done monocularly. The final result was the spherical lens that gave the participant the best aided vision both at distant and at near. In the existence of astigmatism,power of the cylinder was refined with cylindrical lenses after determining the axis.In the instance of presbyopia, plus lenses were added to the distant prescription until the best corrected near vision was achieved.

Analysis of Data

Data were input into Excel spread sheet, cleaned and cross checked for errors and then imported into SPSS version 25 for analysis. These were expressed in frequencies and percentages and presented in tables.

Ethical Considerations

Ethical approval to conduct this research was obtained from the University of Port Harcourt Ethics Committee. This study maintained the tenets of the Helsinki Declaration on study involving human beings. Individual participant's informed consent was obtained.Participation was absolutely voluntary. Participants could freely opt out at any step of the investigation without victimization. All information obtained from participants of this research were treated with utmost confidentiality. No personal identification was stored electronically. There was minimal or no health risk to the investigation's participants.

III. Results

Table 1. Social demographic parameters of the survey population

Parameter	Frequency (percentage)
Sex	
Male	177 (48.9)
Female	185 (51.1)
Age	
<20yrs	57 (15.7)
21-30yrs	12 (3.3)
31-40yrs	17 (4.7)
41-50yrs	69 (19.1)
51-60yrs	95 (26.2)
>60yrs	112 (30.9)
Occupation	
Student	70 (19.3)
Civil servant	113 (31.2)
Self employed	25 (6.9)
Retiree	137 (37.8)
Unemployed	17 (4.7)

Table 1 displays the social demographic parameters of the survey population. More females (51.1%) participated in thissurvey thanmales (48.9%). Also, more people aged above 60 (30.9%) participated which was closely followed by age range 51-60 (26.2%). A significant number of the subjects were retirees (37.8%) followed by civil servants (31.2%).

Table 2.Pattern ofrefractive error in the study population

Refractive error	Frequency (percentage)
Myopia	74 (20.4)
Hyperopia	265 (73.2)
Astigmatism	316 (87.3)
Presbyopia	278 (76.8)

The study population was significantly astigmatic (87.3%), followed by presbyopia (76.8%), hyperopia (73.2%) and myopia (20.4%). Note that the percentages do not add up to hundred since some of the subjects had more than one refractive error.

Table 3: Refractive error by sex in the study population

Refractive Error	Male (n/%)	Female (n/%)
Myopia	33 (44.6)	41(55.4)
Hyperopia	128 (48.3)	137 (51.7)
Astigmatism	161 (50.9)	155 (49.1)
Presbyopia	149 (53.6)	129 (46.4)

Table 3 shows the sex distribution of refractive error in the study. More females (55.4%) had myopia in contrast tomales (44.6%). Similarly, hyperopia was observed more frequently infemales (51.7%) compared to males (48.3%). However, the result showed that astigmatism was observed more in males (50.9%) as opposed to females (49.1%). Similarly, males (53.6%) had presbyopia more than the females (46.4%).

Table 4:Refractive error in study participants by age

Refractive Error	<20Yrs (n/%)	21-30Yrs (n/%)	31-40Yrs (n/%)	41-50Yrs (n/%)	51-60Yrs (n/%)	>60Yrs (n/%)
Myopia	24 (32.4)	8 (10.8)	4 (5.4)	10 (13.5)	11(14.9)	17 (23.0)
Hyperopia	26 (9.8)	3 (1.1)	12 (4.5)	45 (17.0)	82 (31.0)	97 (36.6)
Astigmatism	47 (14.9)	11 (3.5)	15 (4.7)	55 (17.4)	78 (24.7)	110 (34.8)
Presbyopia	0 (0.0)	1 (0.4)	8 (2.9)	67 (24.1)	91 (32.7)	111 (39.9)

Table 4 reveals refractive error among the study population by age. Myopia was detected more in the <20 years (n=24, 32.4%), followed by >60 age group (n=17, 23%), 51-60years group (n= 11, 14.9%), 41-50 years group (n=10, 13.5%), 21-30 years group (n=8, 10.8%) and 31-40years group (n=4, 5.4%).

Hyperopia occurred more in >60years age group (n=97,36.6%), followed by 51-60 years group (n=82, 31.0%), 41-50 years group (n=45, 17.0%), <20 years age group (n=26, 9.8%), 31-40 years group (n=12, 4.5%) and 21-30 years group (n=3, 1.1%).
Astigmatism incidence occurred largest in the more than 60 age group (n=110, 34.8%), followed by 51-60 years group (n=78, 24.7%), 41-50 years (n=55, 17.4%), < 20 years group (n=47, 14.9%), 31-40 years group n=15, (4.7%) and 21-30 years group (n=11, 3.5%).
Presbyopia was detected from 31-40 years group (n= 8, 2.9%) and gradually progressed across age groups; 41-50 years group n=67, (24.1%), 51-60 years group (n=91, 32.7%), >60 years group (n=111, 39.9%).

Table 5: Refractive error by occupation in the study population

Refractive Error	Student	Civil Servant	Self Employed	Retiree	Unemployed
Myopia	31 (41.9)	19 (25.7)	1 (1.4)	20 (27.0)	3 (4.0)
Hyperopia	30 (11.3)	81 (30.6)	24 (9.0)	119 (44.9)	11(4.2)
Astigmatism	59 (18.7)	95 (30.1)	19 (6.0)	129 (40.8)	14 (4.4)
Presbyopia	3 (1.1)	103 (37.0)	22 (7.9)	137 (49.3)	13 (4.7)

Table 5 shows refractive error by occupation in the study population. Myopia was highest among students (n=31, 41.9%), followed by retirees (n=20, 27%), civil servants (n=19, 25.7%), unemployed (n= 3, 4.0%) and self-employed (n=1, 1.4%).
Hypermetropia occurred highest amongthe retirees (n=119, 44.9%) followed by civil servants (n=81, 30.6%), students (n=30, 11.3%), self-employed (n=24, 9.0%) and unemployed (n=11, 4.2%).
The highest incidence of astigmatism was observed among retirees (n=137, 40.8%), civil servant (n=95, 30.1%), student (n=59, 18.7%), self-employed (n=19, 6.0%) and unemployed (n=14, 4.4%).
Presbyopia occurred more in retiree (n=137, 49.3%), civil servants (n=103, 37.0%), self-employed (n=22, 7.9%), unemployed (n=13, 4.7%) and student (n=3, 1.1%).

IV. Discussion

In this study, astigmatism is the most prevalent refractive error (87.3%). This observation is in corroboration with the work of Koroye-Egbe and colleagues[16] in Bayelsa State, Nigeria. Different authors have reported varying prevalence of refractive error in different periods in Nigeria. Abraham et al., reported that myopia was the most prevalent in 2015 whereas Emerole et al., found hypermetropia to be the most prevalent in 2013 [[17].

Our current study revealed that 76.8% of the study participants had presbyopia. This finding is higher thanthe reported 56% in Northern Nigeria by Bagaiya et al. [18] and 31.8% by Adegbehingbe et al. in Western Nigeria [19]. However, the findings of Koroye-Egbe et al. (74.9%) in South-South Nigeria [16] is in tandem with ours in this study.

Other population-based investigations have established that the incidence ofmyopia increases with age[13,20]. According to our current study, there was high myopia incidence in the group of those under 20 (32.4%) and a decline with advancing age. Myopia can sometimes be more prevalentduring childhood as well as early twenties or advanced age for people who enroll in more rigorous near work[21]. Later-life nuclear sclerosis of the lens could be a factorfor the increase in myopia as seen among participants aged 51 years and older[22, 23].

As opposed to females (51.7%), fewer males (48.3%) had hypermetropia. This result is in corroborationwith the outcomes of the Bangladesh and Nigeria National Blindness and Impaired Vision Studies, where it was discovered that men were of higher likelihood of having myopia and women of having hyperopia[13, 24]. Also, in corroboration with the Bangladesh study, myopia incidence was more in females [24]. Furthermore, the Bangladesh study showed myopia was linked to higher levels of educational pursuitsand was more widespread among people who work in offices in contrast to people who are unemployed[24].This is in line with the findings of our currentwork, which indicated that people in "white collar jobs," for instance, the civil servants (25.7%), weremore prone to be myopic compared to individuals who were unemployed (4.1%) or self-employed (1.4%).However, this disagrees with the Nigeria National Blindness and Impaired Vision Study which indicated myopia was more frequent in individuals who were uneducated, laborers, and rural residents[13].

More students were discovered to have myopia (41.9%) than hyperopia (11.3%) in this research.Some investigations have postulatedgenetic alongsideenvironmental factors including education and greater close workas predispositions tomyopia [25].

Males were more likely than females to have astigmatism, and it increases with age (from 41years), this is consistent with some researches[26, 27] and in disagreement with others [22, 23, 28, 29]. Astigmatism is a dynamic condition thatis affected by a number of factors such as age, ethnicity, race, genetics, visual activities, as well as changes to the cornea throughout time[30].

Presbyopia is connected to a number of risk factors, one of which is age[31]. The elasticity of the human eye's natural lens begins to deteriorate with age, limiting its capacity to adapt and focus on targets at near[32]. In this investigation, presbyopia was observed from 31-40 years group (2.9%) and gradually increasedamong the age range of 41-50 years group (24.1%), 51-60 years group (32.7%), >60 years group (39.9%). In addition, presbyopia was observed to be highest among the retirees in this study. Furthermore, presbyopia occurred more in males and this finding is in disagreement with the works of [32-35]which documented female gender as being prone to presbyopia more than their male counterparts.

V. Conclusions

Uncorrected refractive error is a significant contributor to avoidable blindness. The prevalence of myopia, hypermetropia, astigmatism and presbyopia are high among the people of Eleme Local Government Area. The provision of comprehensive refraction services along with the vision care facilities are necessary to deal with the significant public health concerns presented by the prevalent uncorrected refractive error. Furthermore, it is imperative to make spectacles available and accessible to communities of low-income setting.

Financial Support and Sponsorship: Nil

Conflicts of Interest There are no conflicts of interest.

References

[1]. Resnikoff, S. (2008). Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bulletin of the World Health Organization, 86(1), 63–70. https://doi.org/10.2471/BLT.07.041210

[2]. Drover, J. R., Kean, P. G., Courage, M. L., & Adams, R. J. (2008). Prevalence of amblyopia and other vision disorders in young Newfoundland and Labrador children. Canadian Journal of Ophthalmology, 43(1), 89–94. https://doi.org/10.3129/i07-187

[3]. Naidoo, K., & Ravilla, D. (2007). Delivering refractive error services: primary eye care centres and outreach. Community Eye Health, 20(63), 42–44. http://www.ncbi.nlm.nih.gov/pubmed/17971910

[4]. Kandel, H., Khadka, J., Goggin, M., & Pesudovs, K. (2017). Impact of refractive error on quality of life: a qualitative study. Clinical & Experimental Ophthalmology, 45(7), 677–688. https://doi.org/10.1111/ceo.12954

[5]. Bourne, R. R. A., Stevens, G. A., White, R. A., Smith, J. L., Flaxman, S. R., Price, H., Jonas, J. B., Keeffe, J., Leasher, J., Naidoo, K., Pesudovs, K., Resnikoff, S., & Taylor, H. R. (2013). Causes of vision loss worldwide, 1990–2010: a systematic analysis. The Lancet Global Health, 1(6), e339–e349. https://doi.org/10.1016/S2214-109X(13)70113-X

[6]. Thulasiraj, R. D., & Aravind, S. (2003). Spectacles for the Millions Addressing a Priority of "Vision 2020 - The Right to Sight." Community Opthalmology, 3(4), 19–21. http://v2020eresource.org/content/files/spectacles_oct-03.pdf

[7]. Kempen, J. H., Mitchell, P., Lee, K. E., Tielsch, J. M., Broman, A. T., Taylor, H. R., Ikram, M. K., Congdon, N. G., O'Colmain, B. J., & Eye Diseases Prevalence Research Group. (2004). The prevalence of refractive errors among adults in the United States, Western Europe, and Australia. Archives of Ophthalmology (Chicago, Ill.: 1960), 122(4), 495–505. https://doi.org/10.1001/archopht.122.4.495

[8]. Holden, B. A. (2008). Global Vision Impairment Due to Uncorrected Presbyopia. Archives of Ophthalmology, 126(12), 1731. https://doi.org/10.1001/archopht.126.12.1731

[9]. Vitale, S., Cotch, M. F., & Sperduto, R. D. (2006). Prevalence of Visual Impairment in the United States. JAMA, 295(18), 2158. https://doi.org/10.1001/jama.295.18.2158

[10]. Tasman, W., & Jaeger, E. A. (2012). Duane's Ophthalmology 2013. Lippincott Williams \& Wilkins. https://books.google.com.ng/books?id=A9l1kgEACAAJ

[11]. Grosvenor, T. P. (1996). Primary Care Optometry: Anomalies of Refraction and Binocular Vision.Butterworth-Heinemann. https://books.google.com.ng/books?id=RqBsAAAAMAAJ

[12]. Naidoo, K., & Jaggernath, J. (2012). Uncorrected refractive errors. Indian Journal of Ophthalmology, 60(5), 432. https://doi.org/10.4103/0301-4738.100543

[13]. Ezelum, C., Razavi, H., Sivasubramaniam, S., Gilbert, C. E., Murthy, G. V. S., Entekume, G., & Abubakar, T. (2011). Refractive Error in Nigerian Adults: Prevalence, Type, and Spectacle Coverage. Investigative Opthalmology & Visual Science, 52(8), 5449. https://doi.org/10.1167/iovs.10-6770

[14]. Araoye M.O. (2004). Research Methodology with Statistics for Health and Social Sciences. Ilorin: Nathadex publishers.pp 115-121.

[15]. Onua, A. A., Pedro-Egbe, C. N., & Babatunde, S. (2012). Prevalence of Refractive Error in a Rural Ogoni Community in Southern Nigeria. Nigerian Journal of Ophthalmology, 20, 30–32.

[16]. Koroye-Egbe, A., Ovenseri-Ogbomo, G., & Adio, A. (2011). Refractive Error Status in Bayelsa State, Nigeria. Nigerian Journal of Ophthalmology, 18(2). https://doi.org/10.4314/njo.v18i2.70764

[17]. Emerole, C., Nneli, R., & Osim, E. (2013). Astigmatism: Prevalence, Distribution and Determinants in Owerri, Nigeria. Journal of Experimental and Clinical Anatomy, 12(2), 87. https://doi.org/10.4103/1596-2393.127970

[18]. Bagaiya, T., & Pam, V. (2004). Refractive errors in Kaduna, Nigeria. Nigerian Journal of Surgical Research, 5(3). https://doi.org/10.4314/njsr.v5i3.12250

[19]. Adegbehingbe, B., Majekodunmi, A., Akinsola, F., & Soetan, E. (2004). Pattern Of Refractive Errors At Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria. Nigerian Journal of Ophthalmology, 11(2). https://doi.org/10.4314/njo.v11i2.11932

[20]. Jacobsen, N., Jensen, H., & Goldschmidt, E. (2008). Does the Level of Physical Activity in University Students Influence Development and Progression of Myopia?—A 2-Year Prospective Cohort Study. Investigative Opthalmology & Visual Science, 49(4), 1322. https://doi.org/10.1167/iovs.07-1144

[21]. Hyman, L. (2007). Myopic and Hyperopic Refractive Error in Adults: An Overview. Ophthalmic Epidemiology, 14(4), 192–197. https://doi.org/10.1080/09286580701535517

[22]. Francisco Gomez-Salazar, A. C.-R. H. G.-C. C. C.-Z. M. C.-F. N. L.-S. (2017). Refractive errors among children, adolescents and adults attending eye clinics in Mexico. International Journal of Ophthalmology. https://doi.org/10.18240/ijo.2017.05.23
[23]. Hrynchak, P. K., Mittelstaedt, A., Machan, C. M., Bunn, C., & Irving, E. L. (2013). Increase in Myopia Prevalence in Clinic-Based Populations Across a Century. Optometry and Vision Science, 90(11), 1331–1341. https://doi.org/10.1097/OPX.0000000000000069
[24]. Bourne, R. R. A., Dineen, B. P., Huq, D. M. N., Ali, S. M., & Johnson, G. J. (2004). Correction of Refractive Error in the Adult Population of Bangladesh: Meeting the Unmet Need. Investigative Opthalmology & Visual Science, 45(2), 410. https://doi.org/10.1167/iovs.03-0129
[25]. Abraham, E., & Megbelayin, E. (2015). Pattern of refractive errors among ophthalmic outpatients of University of Uyo Teaching Hospital, Uyo, Nigeria. Nigerian Journal of Ophthalmology, 23(2), 39. https://doi.org/10.4103/0189-9171.170965
[26]. Gudmundsdottir, E., Jonasson, F., Jonsson, V., Stefánsson, E., 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 Ophthalmologica Scandinavica, 78(6), 642–646. https://doi.org/10.1034/j.1600-0420.2000.078006642.x
[27]. Leung, T.-W., Lam, A. K.-C., Deng, L., & Kee, C.-S. (2012). Characteristics of Astigmatism as a Function of Age in a Hong Kong Clinical Population. Optometry and Vision Science, 89(7), 984–992. https://doi.org/10.1097/OPX.0b013e31825da156
[28]. Malu, K., & Ojabo, C. (2014). Refractive errors in patients attending a private hospital in Jos, Nigeria. Nigerian Journal of Clinical Practice, 17(1), 106. https://doi.org/10.4103/1119-3077.122863
[29]. Kragha, I. K. (1987). The distribution of refractive errors in Nigeria. Ophthalmic & Physiological Optics: The Journal of the British College of Ophthalmic Opticians (Optometrists), 7(3), 241–244.
[30]. Read, S. A., Collins, M. J., & Carney, L. G. (2007). A review of astigmatism and its possible genesis. Clinical and Experimental Optometry, 90(1), 5–19. https://doi.org/10.1111/j.1444-0938.2007.00112.x.
[31]. Bourne, R. R. A., Flaxman, S. R., Braithwaite, T., Cicinelli, M. v, Das, A., Jonas, J. B., Keeffe, J., Kempen, J. H., Leasher, J., Limburg, H., Naidoo, K., Pesudovs, K., Resnikoff, S., Silvester, A., Stevens, G. A., Tahhan, N., Wong, T. Y., Taylor, H. R., Bourne, R., … Zheng, Y. (2017). Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis. The Lancet Global Health, 5(9), e888–e897. https://doi.org/10.1016/S2214-109X(17)30293-0
[32]. Nirmalan, P. K., Krishnaiah, S., Shamanna, B. R., Rao, G. N., & Thomas, R. (2006). A Population-Based Assessment of Presbyopia in the State of Andhra Pradesh, South India: The Andhra Pradesh Eye Disease Study. Investigative Opthalmology & Visual Science, 47(6), 2324. https://doi.org/10.1167/iovs.05-1192
[33]. Burke, A. G., Patel, I., Munoz, B., Kayongoya, A., Mchiwa, W., Schwarzwalder, A. W., & West, S. K. (2006). Population-Based Study of Presbyopia in Rural Tanzania. Ophthalmology, 113(5), 723–727. https://doi.org/10.1016/j.ophtha.2006.01.030
[34]. Muhammad, R., & Jamda, M. (2016). Presbyopic correction coverage and barriers to the use of near vision spectacles in rural Abuja, Nigeria. Sub-Saharan African Journal of Medicine, 3(1), 20. https://doi.org/10.4103/2384-5147.176301
[35]. Laitinen, A., Koskinen, S., Härkänen, T., Reunanen, A., Laatikainen, L., & Aromaa, A. (2005). A Nationwide Population-Based Survey on Visual Acuity, Near Vision, and Self-Reported Visual Function in the Adult Population in Finland. Ophthalmology, 112(12), 2227–2237. https://doi.org/10.1016/j.ophtha.2005.09.010

Henry-Ndubuka, C. E, et. al. "Pattern of Refractive Error in Eleme Local Government Area, River State, Nigeria." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 22(2), 2023, pp. 07-13.