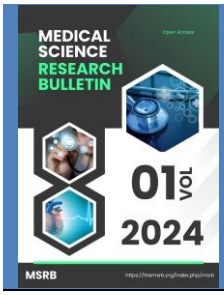

Medical Science Research Bulletin

e-ISSN: 3050-5569
p-ISSN: 3050-5550

Vol. 01(03): 33-37, August 2024

Home Page: https://themsrb.org/index.php/msrb

Studies on the Effect of Oxidative Stress on Glaucoma

Nsonwu Magnus[1], Ozims Stanley J[2], Nnodim Johnkennedy[3]

[1]Department of Optometry, Imo State University, Owerri, Nigeria

[2]Department of Public Health, Imo State University, Owerri, Nigeria

[3]Department of Medical Laboratory Science, Imo State University, Owerri, Nigeria

KEYWORDS:

Effect, oxidative stress, glaucoma

Corresponding Author:
Nsonwu Magnus

ABSTRACT

A Cross Sectional study to evaluate the levels of Vitamin A,Vitamin C, Vitamin E, GPX, SOD, and MDA in cataract attending clinic at Federal Teaching Hospital, Owerri was carried out. A total of subjects comprising 250 cataract patients and control and within the ages of 25 and 70 years were recruited for the study.. All kits were commercially purchased and the manufacturer's standard operational procedures were strictly followed. Data was analyzed using the software statistical package for social sciences version 21, windows 9, values were expressed as mean ± standard deviation, student t-test and analysis of variance were used to analyze the difference in experimental variables, Results showed that there were significant lower levels of Vitamin A (3.30±0.83mg/dl), Vitamin C(30.96±5.54 mg/dl), Vitamin E (8.99±1.49 mg/dl), (5.46±1.15, 44.35±6.40, 13.95±3.86) respectively ($p<0.05$). There was a significant decrease in MDA compared with the control $p<0.05$).

INTRODUCTION

The eye disease known as glaucoma is caused by an unusually high fluid pressure inside the eye. The pressure damages your optic nerve, altering the way that visual information gets to your brain. Undiagnosed and untreated glaucoma can result in vision loss and blindness in one or both eyes. Glaucoma frequently runs in families [1].

There are two main subtypes of glaucoma. Since open-angle glaucoma develops gradually over time, alterations in vision might not be seen until the disease is more advanced. Closed-angle glaucoma might develop unexpectedly. It causes pain and quickly leads to blindness [2].

Glaucoma is a leading cause of irreversible vision loss and blindness in Nigeria. It is a group of conditions that affect the optic nerve, which is necessary for good vision. This damage causes an abnormally high pressure within the eye. The elderly are the main victims. There are glaucoma types that don't exhibit any noticeable symptoms. The effect is so slow that there may not be any noticeable changes in vision until the condition has progressed to an advanced stage. There are several glaucoma indications and symptoms that might manifest depending on the kind and stage of the condition [3].

It is caused by increased intraocular pressure, which compresses and destroys the optic nerve.

Damage to the optic nerve, which prevents it from conveying visual information to the brain, causes blindness. The development and progression of acute closed-angle glaucoma are significantly influenced by stress because it can alter the patient's intraocular pressure (IOP), which can then have an effect on their emotional state.There is some evidence that the production of glaucoma is linked to psychophysiological stress. Many Nigerians suffer from glaucoma, a public health concern. because information about the oxidative stress of glaucoma and its frequency in Nigeria is lacking.Consequently, the need for this work.Glaucoma is a group of eye conditions that damage the optic nerve.The optic nerve, which carries visual information from the eye to the brain, is necessary for sharp vision.

Optic nerve injury is often linked to elevated intraocular pressure. But normal ocular pressure can also lead to the development of glaucoma [4].Although glaucoma can affect anyone, its incidence is higher in the elderly.It is one of the leading causes of blindness in those over 60. Many kinds of glaucoma have no symptoms at all. Because the effect is so gradual, you might not notice a change in eyesight until the problem is more advanced.It's critical to have routine eye exams that include an assessment of your eye pressure. Early detection of glaucoma may prevent or reduce the loss of eyesight.Patients with glaucoma will need to have treatment or monitoring for the rest of their lives. You will experience different symptoms of glaucoma depending on the kind and stage of your condition [5].

Patchwork blind spots slowly appear on your side vision in the early stages of open-angle glaucoma. Side vision is often referred to as peripheral vision. subsequently experiencing difficulty seeing objects in your range of view [6]

The symptoms of acute angle-closure glaucoma include red eyes, coloured rings around lights, nausea or vomiting, intense headaches, and painful eye discomfort. Early stages of normal-tension glaucoma are symptomless; later stages include side vision loss and impaired vision. A dull or clouded eye, uncrying tears, blurred vision, developing nearsightedness, headache, and increased blinking are some of the signs of childhood glaucoma [7].

Pigmentary glaucoma is characterised by surrounding light halos, impaired vision during exercise, and a progressive loss of side vision.

Abrupt onset of symptoms could be attributed to acute angle-closure glaucoma. Two symptoms include eye pain and a strong headache. You need to start treatment immediately. Make an immediate call to the office of an ophthalmologist, or visit the emergency hospital [8].The effect of damage to the optic nerve is glaucoma. Your vision becomes partially blind as a result of the slow degeneration of this nerve. For unknown causes, increased ocular pressure is usually associated with this nerve damage [9]. Elevated ocular pressure results from a build-up of fluid that moves throughout the inside of the eye. This material is also known as the aqueous humour. Normally, it leaves the body through a tissue at the interface of the cornea and iris.

This tissue is also known as the trabecular meshwork. The cornea plays an essential role in vision because it permits light to enter the eye. When the eye generates too much fluid or the drainage system isn't working properly, eye pressure can increase [10]. This kind of glaucoma is the most common. The drainage angle between the iris and cornea is still open. Nevertheless, the drainage system isn't operating efficiently in some places. This could cause an eye pressure rise that is gradual and progressive.This kind of glaucoma arises with iris enlargement. The drooping iris blocks the drainage angle completely or partially. Consequently, the eye's pressure increases and liquid is unable to pass through it. Angle-closure glaucoma may progress gradually or rapidly [11].

The specific cause of optic nerve injury in the presence of normal intraocular pressure is unknown. The optic nerve's blood supply could be less or more sensitive. This limited blood flow could be caused by disorders that affect circulation or by the buildup of fatty deposits in the arteries. The buildup of fatty deposits in arteries is referred to as atherosclerosis [13].

In addition, glaucoma is associated with numerous alterations in the body's biochemistry as well as related socioeconomic issues. Patients who are affected face additional financial challenges in managing their condition. It is estimated that glaucoma affects around people in Nigeria. Despite this, nothing is known about the incidence of glaucoma in Imo State.

This takes place against a backdrop of quickly shifting sociocultural, economic, and biological indicators, such as population ageing, a decline in physical activity, a general lack of knowledge about wellness and healthy living practices, shifting eating habits, etc.[14] It is difficult to construct a thorough picture of the prevalence of eye problems in Imo State due to a lack of trustworthy statistical data. In Imo State, Nigeria, the current study aims to assess the frequency of various eye diseases, the oxidative stress they generate, their capacity to advance, their distribution, and their socioeconomic implications. It is anticipated that this study's findings will support the implementation of suitable interventions in Imo State, Nigeria, for the management of glaucoma and general prevention.

MATERIALS AND METHODS

Study area

The study area is Imo State. Imo State is one of the 36 States of Nigeria, it is located in the Southeast geopolitical zone. Imo State lies within latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an area of around 5,100 sq km. It is bordered by Abia State on the East, by the River Niger and Delta State on the west, by Anambra State to the north and Rivers State to the south. Besides Owerri, Imo State's major towns are Isu, Okigwe, Oguta, Orlu, Mbaise, Mbano, Mbaitoli, Mbieri, Orodo, Nkwerre and Orsu

Population

The estimated population is 4.8 million and the population density varies from 230-1,400 people per square kilometer (National Bureau of Statistics, 2007)

Climate

The rainy season begins in April and lasts until October with annual rainfall varying from 1,500mm to 2,200mm (60 to 80 inches). An average annual temperature above 20 °C (68.0 °F) creates an annual relative humidity of 75%. With humidity reaching 90% in

the rainy season. The dry season experiences two months of Harmattan from late December to late February. The hottest months are between January and March

Government

The state has a three-tier administrative structure: State, Local and Autonomous community levels. The three arms at state level are the Executive, the Legislative and the Judiciary. The executive arm is headed by an elected Governor who is assisted by a deputy governor, commissioners and executive advisers

Language

Imo state is a predominantly Igbo speaking state, with Igbo people constituting a majority of 98% .

Ethical consideration

Letters of approval/permission to administer questionnaires on respondents were presented to management of health institutions for approval before they were administered to respondents. Also, the consent of those living with eye disease were sought for before they were presented with questionnaires. Similar consent was sought from the general public before the questionnaires were administered on them.

Study design

Descriptive and analytical study designs were used in this study. Descriptive design was used to investigate the distribution of different eye diseases, while analytical design was used to analyse the determinants of the glaucoma distribution as well malondiaoxide vitamin c, vitamin E and enzymatic antioxidants that represent the oxidative stress

This study involved patients at the Imo State University Eye Clinic in Owerri, the Umuguma Specialist Hospital in Owerri, and the Federal Medical Centre (FMC) in Owerri. They were divided into categories and under control. Patients with eye diseases have their levels of Vitamins C and E, antioxidant enzymes, a result of lipid peroxidation, measured using a routine procedure.

Survey methods and sampling technique

Random, target and stratified sampling survey methods were employed in this study. Random sampling was used in collecting data from the hospitals.

Sample size

Sample size calculation

Sample size was calculated using simple formular .

$N=Z^2 p(1- p)/d^2$

Where N=sample size, Z=z statistic for a level of confidence, P= Expected prevalence or proportion, d=precision, Z=1.96 for the level of confidence of 95%, P=10.2% (1.02) prevalence of sickle cell, and D=5% (0.05)

$N=1.96^2 x1.02(1- 1. 02)/0.05^2$

N=169.36

Study Population

The population for this study comprised a total of 500 patients. 250 male and 250 female outpatients. These patients were drawn from government owned tertiary care facilities, including the Federal Medical Centre and State Specialist Hospital both in Owerri.

Sample and Sampling Technique

In this aspect, the study population were first be sampled by the symptoms and nature of eye conditions observed in various cities in the Imo State of Nigeria. They were further classified into five age groups, and by gender (male and female). The data collected were described (presented), using frequency tables.

Method of data collection

Research instrument for data collection were questionnaires and materials such as test stripes, lancets, alcohol pads and Chemical analyzers; others are blood pressure measuring kits, measuring tape and weighing balance were used for physical examination.

Laboratory methods and procedure

All kits were purchased from Randox Diagnostic LTD, UK

The determination of vitamin C and E, malondialdehyde Glutathione Peroxidase, Superoxide dismutase, catalase by standard method [15]

Statistical Analysis

Generated data were put into Tables and Charts. Descriptive Statistics: mean, relative standard error and standard deviation were used to measure the level of skewness among data that were obtained in relation to various parameters that were considered in this study. This was computed using SPSS statistical software version 17.0 (SPSS, 2009).

RESULTS

Table 1. Comparison of the parameters between the different eye disease groups and the control group using LSD post hoc analysis

Parameters	Groups		Mean Difference	P-value
	Gluacoma	Control		
Vitamin A(mg/dl)	3.30±0.83	5.46±1.15	-2.16	0.001*
Vitamin C(mg/dl)	30.96±5.54	44.35±6.40	-13.39	0.001*
Vitamin E(mg/dl)	8.99±1.49	13.95±3.86	-4.96	0.001*
GPX (iu/L)	13.76±1.81	16.63±3.13	-2.87	0.001*
SOD (iu/L)	3.33±0.83	5.04±0.81	-1.71	0.001*
MDA(mmol/L)	22.03±2.73	28.48±2.72	-6.44	0.001*

DISCUSSION

Globally, glaucoma is the primary cause of blindness. These eye diseases have many complicated, multifactorial causes that are still not fully understood; however, their pathology has been linked to mechanisms including high lipid peroxidation, low antioxidant defence, increased generation of reactive oxygen species (ROS), oxidative stress, inflammation, and oxidative DNA damage [16]. Age-related macular degeneration (AMD) and other retinal and optic nerve degenerative illnesses, such as glaucoma, are brought on by ROS-induced cell damage and ageing, which also causes corneal degeneration and cataracts. This study evaluated the levels of many antioxidant enzymes and vitamins in connection to the development of glaucoma.

In this study, the diastolic blood pressure was greater ($p < 0.05$) and the levels of Vitamin A, C, E, GPX, and SOD were considerably lower in the glaucoma group than in the control group. Consistent with our results, glaucoma patients' blood levels of SOD and GPX were found to be considerably lower than those of the controls. It has also been documented that glaucoma patients had lower levels of SOD, Catalase, ascorbic acid, glutathione, vitamin E, and beta carotene than the equivalent controls [17]. Since the eye is a metabolically active structure that is continually exposed to sunlight, it is susceptible to oxidative stress, photoxidative damage, and reactive oxygen species (ROS), all of which can lead to glaucoma and other eye problems [10].

Consequently, it's possible that the decreased levels of antioxidants (Vitamins A, C, E, GPX, and SOD) in glaucoma patients relative to controls are due to their depletion in counteracting the harmful effects of ROS and free radicals [9].Our observations support the findings that glaucoma patients have higher MDA, reduced TAS, and decreased SOD [12].The heightened ROS that has been linked to glaucoma may be the cause of the lower levels of vitamin A, C, E, GPX, and SOD seen in these patients.Oxidative stress has been linked to the cell death in glaucoma, a neurodegenerative disease marked by the gradual degeneration of retinal ganglion cells.Abnormalities in the morphology and function of the trabecular meshwork (TM) resulting from an environment of oxidative stress have been linked to glaucoma.

TM cells are exposed to higher concentrations of H2O2 in the reduced reactive antioxidant environment. This results in oxidative damage to the structural and functional elements of mitochondria and other organelles in TM endothelial cells, including mtDNA, proteins, and lipids membrane damage that raises intraocular pressure (IOP), retinal damage in the optic nerve, and pathologic consequences in the development of glaucoma. [16] Among glaucoma patients, a noteworthy inverse relationship was found between catalase and vitamin C and a favourable association between GPx and vitamin C. Consistent with our findings, another study found that vitamin C supplementation raised tissue vitamin C levels and total glutathione peroxidase activity while lowering protein carbonyls, catalase, and malondialdehyde (MDA) levels in both treated and untreated mice.

There is evidence linking vitamin C to multidirectional cellular actions. There is a "second face" to vitamin C, one of the antioxidants that scavenges free radicals. Nevertheless, the antioxidant effects of vitamin C outweigh the prooxidant effects. [18]

CONCLUSION

According to the study's findings, those who have glaucoma may have reduced amounts of antioxidant vitamins and enzymes, such as GPX, SOD, vitamin A, C, and e. Lipid peroxidation and antioxidant depletion appear to be exacerbated by the hypertension linked to hypertensive retinopathy. Supplementing with antioxidants may be essential for slowing the onset and progression of eye disorders.

REFERENCES

1. Kaur J, Kukreja S, Kaur A, Malhotra N, Kaur R (2012). The oxidative stress in cataract patients. J Clin Diagn Res. 6(10):1629-32.

2. Ghazala, ASL, Siddiqui JA, Khanam KMS.(2019) Oxidative stress and antioxidant vitamins in cataract patients. International Journal of Research in Medical Sciences. 7(5): 1568-1571).
3. Li S, Shao M, Li Y, Li X, Wan Y, Sun X, Cao W (2020). Relationship between Oxidative Stress Biomarkers and Visual Field Progression in Patients with Primary Angle Closure Glaucoma. Oxid Med Cell Longev. 5;2020:2701539.
4. Shahsavari G, Mohammad pour Konani A, Miraftabi A (2015). Comparative study of the oxidative stress markers and antioxidant profile in patients with primary open-angle glaucoma and healthy subjects. J Kermanshah Univ Med Sci. 19(3):e69875.
5. Mrowicka, M.; Mrowicki, J.; Szaflik, J.P.; Szaflik, M.; Ulinska, M.; Szaflik, J.; Majsterek, I.(2017) Analysis of antioxidative factors related to AMD risk development in the polish patients. *Acta Ophthalmol. 95*, 530–536.
6. Zafrilla, P.; Losada, M.; Perez, A.; Caravaca, G.; Mulero, J.(2013) Biomarkers of oxidative stress in patients with wet age related macular degeneration. *J. Nutr. Health Aging 17*, 219–222.
7. Arıkan Yorgun, M.; Toklu, Y.; Altınkaynak, H.; Tanrıverdi, B.; Ergin, M.; Biçer, C.(2018) A Novel Tool for the Assessment Oxidative Stress in Age-Related Macular Degeneration: Thiol/Disulfide Homeostasis Revisited. *Curr. Eye Res. 41*, 1584–1589.).
8. Ferreira, S.M.; Lerner, S.; Brunzini, R.; Evelson, P.A.; Llesuy, S.F (2004). Oxidative stress markers in aqueous humor of glaucoma patients. *Am. J. Ophthalmol. 137*, 62–69.).
9. Cadenas S, Rojas C, Pérez-Campo R, López-Torres M, Barja G (1994). Effect of dietary vitamin C and catalase inhibition of antioxidants and molecular markers of oxidative damage in guinea pigs. Free Radic Res.;21(2):109-18.
10. Kaźmierczak-Barańska J, Boguszewska K, Adamus-Grabicka A, Karwowski BT (2020). Two Faces of Vitamin C—Antioxidative and Pro-Oxidative Agent. *Nutrients*. 12(5):1501.
11. Griendling KK, Camargo LL, Rios FJ, Alves-Lopes R, Montezano AC, Touyz RM. (2021) Oxidative Stress and Hypertension. Circ Res. 128(7):993-1020. doi:
12. Ahmad KA, Yuan Yuan D, Nawaz W, Ze H, Zhuo CX, Talal B, Taleb A, Mais E, Qilong D (2017). Antioxidant therapy for management of oxidative stress induced hypertension. *Free Radic Res.* 51:428–438
13. Myint PK, Luben RN, Wareham NJ, Khaw KT (2011). Association between plasma vitamin C concentrations and blood pressure in the European prospective investigation into cancer-Norfolk population-based study. *Hypertension.* 58:372–379.
14. Wierzbowska J, Wojtkiewicz S, Zbieć A, Wierzbowski R, Liebert A, and. Maniewski R (2014), Prolonged postocclusive hyperemia response in patients with normal-tension glaucoma," Medical Science Monitor, 2607–2616.
15. Dammak A, Pastrana C, Martin-Gil A, Carpena-Torres C, Peral Cerda A, Simovart M, Alarma P, Huete-Toral F, Carracedo G (2023). Oxidative Stress in the Anterior Ocular Diseases: Diagnostic and Treatment. *Biomedicines*. 11(2):292
16. Katta, A.V.; Katkam, R.V.; Geetha, H (2013). Lipid peroxidation and the total antioxidant status in the pathogenesis of age related and diabetic cataracts: A study on the lens and blood. *J. Clin. Diagn. Res. 7*, 978–981
17. Zhang, Y.; Jiang, W.; Xie, Z.; Wu, W.; Zhang, D (2015). Vitamin E and risk of age-related cataract: A meta-analysis. *Public Health Nutr. 18*, 2804–2814.
18. Wang, A.; Han, J.; Jiang, Y.; Zhang, D. Association of vitamin A and β-carotene with risk for age-related cataract: A meta-analysis. *Nutrition* 2014, *30*, 1113–1121.)
19. Virgolici B, Stoian I, Muscurel C, Maracine M, Popescu L, Moraru C(2009). The systemic redox modifications in senile cataracts. *Rom. J. Intern. Med.* 47(3):279–87.