**Original Research Article**

**EVALUATION OF SOME ANTIOXIDANTS AND HAEMATOLOGICAL INDICES IN GLAUCOMA PATIENTS IN BAYELSA STATE, SOUTHERN NIGERIA**

**ABSTRACT**

**Introduction**: Glaucoma is a progressive neurodegenerative eye disorder that can cause irreversible damage to the optic nerve resulting in complete blindness if left untreated.

**Aim**: This study evaluated some antioxidants levels and haematological indices in glaucoma patients.

**Methods**: A cross-sectional study design was used in this investigation to examine the relationship between variables, and a total of 80 subjects comprising; 50 glaucoma patients and 30 apparently healthy control subjects were selected for the study. Following standard operating protocols, five milliliters of venous blood were aseptically drawn from each patient via the cubital fossa region and dispensed in ethylene diamine tetra-acetic acid and plain sample containers. The blood sample was used for determination of biochemical parameters: uric acid, albumin, bilirubin, Superoxide dismutase, catalase, and malondialdehyde using spectrophotometric techniques, and haematological parameters: packed cell volume, haemoglobin, total white blood cell count, neutrophil, lymphocytes, eosinophils, basophils, monocytes, and platelet count were measured using the Sysmex automated haematology analyser. Statistical analaysis was done using Special Package for Social Sciences (SPSS) version 23.0 and p<0.05 was considered statistically significant.

**Results**: Serum uric acid, albumin, total bilirubin and conjugated bilirubin levels in the glaucoma patients were significantly (p<0.05) lower than the non-glaucomatous subjects. Serum superoxide dismutase, catalase and malondialdehyde levels showed no significant difference when compared with the control subjects. Packed cell volume, haemoglobin, total white blood cell count, and platelets showed no significant (p>0.05) difference in the glaucoma patients compared to the control subjects. However, a statistically significant decrease in eosinophil count (p<0.05) was observed in glaucoma patients compared to control subjects which indicated a significant association between glaucoma and eosinopenia.

**Conclusion**: This finding suggests that reduced eosinophil level may be a potential risk for glaucoma.

**Keywords:** Antioxidants, Glaucoma, Haematological Indices, Malondialdehyde

**INTRODUCTION**

Glaucoma is a neurodegenerative disease with a complex origin that primarily damages the optic nerve and retinal ganglion cells. If left unmanaged, it can result in irreversible or complete vision loss (Tham et al., 2014). By 2020, it was estimated to impact around 80 million individuals, with projections indicating an increase to 111.8 million by 2040, particularly affecting a larger population in Asian and African regions (Tham et al., 2014). Glaucoma is one of the topmost causes of blindness globally, and it is the second most common cause of blindness in Nigeria, with an incidence of 19% (Akinlabi et al., 2009).

Glaucoma is classified into two primary types: open-angle glaucoma and closed-angle glaucoma. These types are subdivided into primary open angle glaucoma, primary angle closure glaucoma and secondary glaucoma (He et al., 2006). Primary open-angle glaucoma is the most widespread type of glaucoma, which is characterized by a gradual obstruction of drainage channels that raises intraocular pressure and gradually damages the optic nerve (Douglass et al., 2023). Primary angle-closure glaucoma occurs when the iris bends forward, creating direct contact with the trabecular meshwork, which blocks the outflow of aqueous humor from the eye. The secondary glaucoma arises as a result of another illness, trauma, or drug that raises intraocular pressure, and damages optic nerve which impair vision (Sena et al., 2017)

The development of glaucoma is influenced by multiple factors and the exact pathways and mechanisms are not yet fully understood. Nonetheless, it has been demonstrated that several contributing risk factors, including vascular alterations, age, race, raised glutamate levels, corneal thickness, elevated intraocular pressure, and genetic variables, play a major role to the development of glaucoma ((Akinlabi et al., 2009; Zhang et al., 2011). Microvascular injury can result from hyper-viscosity brought on by alterations of blood cells and components of plasma. Impaired nitric oxide metabolism, endothelial dysfunction, neuroinflammation and vasospasm have been implicated as possible mechanisms of glaucoma (Astafurov et al., 2014).

Primary haematological disorders are usually uncommon, while haematological manifestations due to other diseases occur regularly. Haemorrhagic glaucoma is a medical complication of vascular disorder that is highly associated with glaucoma development and progression (Lee et al., 2021). Haematological indices are measurable components of blood like red blood cells, white blood cells and platelets, which originate from the haemopoeitic stem cell (Azuonwu et al., 2017). The evaluation of hematological indices plays a crucial role in healthcare, as they serve as essential indicators for assessing immune function, guiding treatment decisions, and monitoring disease progression and therapeutic outcomes. To ensure accurate diagnosis and effective patient management, these indices are routinely analyzed (Amilo et al., 2024). Over the past decade, the understanding of glaucoma's causes has shifted from a solely pressure-based theory to an integrated mechanical and vascular perspective (Delaney et al., 2006). Alterations in blood cell properties and plasma components leading to hyper-viscosity may contribute to microvascular damage (Mannini et al., 2007). Additionally, factors such as reduced nitric oxide availability, endothelial dysfunction, and vasospasms are increasingly associated with glaucoma (Delaney et al., 2006).

Oxidative stress is thought to be a major etiological component that becomes increasingly important in the development of glaucoma (Goyal et al., 2013). According to data, an imbalance between oxidative stress and antioxidant defense activity contributes to the development of glaucoma and other ocular diseases (Yi-Jen Hsueh et al., 2022; Kimura et al. 2017). According to Sacca et al. (2020), oxidative stress may have an impact on the retinal ganglion cells and other retinal cells in the posterior part of the eye. It may also cause degeneration of the human trabecular meshwork in the anterior part of the eye, which raises intraocular pressure and sets off the glaucoma pathogenetic cascade (Zhao et al., 2017).

Antioxidants, both enzymatic and non-enzymatic, function as defense mechanisms for ocular tissues against oxidative stress ((Yi-Jen Hsueh et al., 2022). They may help protect against glaucoma through various mechanisms, including lowering intraocular pressure, supporting vascular health, and preventing the loss of retinal ganglion cells (Jabbehdari et al., 2021). Key enzymatic antioxidants include superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase, while non-enzymatic antioxidants such as uric acid, albumin, vitamin C, and vitamin E play a crucial role as major ocular antioxidants (Wojcik et al., 2013). According to Das et al. (2017), bilirubin and albumin have antioxidant properties and may be utilized as blood biomarkers for disorders linked to oxidative stress. An imbalance between oxidative stress and the body's antioxidant defenses plays a role in the development of various eye diseases. As a result, antioxidants may serve as biomarkers for prognosis and as potential therapeutic targets for managing conditions linked to oxidative stress (Umapathy et al., 2013). Abu-Amero and colleagues, (2013) and Abu-Amero and colleagues, (2014) have shown a decrease in total antioxidant status (TAS) among glaucoma patients.

It has been reported that antioxidants like albumin, bilirubin, and uric acid have demonstrated a significant reduction in neurodegenerative diseases, but the nexus between serum uric acid, or albumin or bilirubin and glaucoma is unclear (Qin et al., 2015). Several authors have evaluated the role of antioxidants in glaucoma taking into consideration that there is a strong link between oxidative stress and the development of glaucoma. However, the results obtained by different authors has been conflicting. Also, there are only few studies carried out on the assessment of haematological indices in glaucoma with conflicting results. As a result, this study aimed to evaluate some haematological parameters and some plasma enzymatic and nonenzymatic antioxidants levels in glaucoma patients.

**2.0 MATERIALS AND METHODS**

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### **2.1 Study Design and Subjects**

The study utilized a cross-sectional study design, which was carried between July, 2022 and May, 2023. The study comprises of fifty (50) male and female subjects diagnosed with glaucoma, who visited the Ophthalmology Department, Niger Delta University Teaching Hospital (NDUTH) Okolobiri, Bayelsa State, between July, 2022 and May, 2023. Inclusion criteria of this study include; subjects diagnosed with any type of glaucoma, glaucoma patients without a known metabolic disorder, male and female subjects who consented to the study and are within the age of 18 – 65 years. Exclusion criteria include; glaucoma patients with a known chronic metabolic, haematological and immunological disorder like diabetes, hypertension, coagulopathy, anemia, liver and renal diseases were excluded. Chronic smokers and alcoholics, and subjects who do not consent to the study were also excluded. The study also included a control group of thirty (30) age-matched subjects who were apparently healthy. The control subjects selected for this study had no history of ocular diseases and underwent the same examinations as the patients. They were also not on any medication and were non-smokers. Prior to the study, ethical approval was obtained from the Research and Ethical Committee of Niger Delta University Teaching Hospital, Okolobiri, Yenagoa, Bayelsa State. Additionally, informed consent was obtained from all participants before their enrollment.

**2.2 Collection of Blood Samples**

Venous blood samples (5ml) were collected from all subjects using aseptic techniques via the cubital fossa region following standard operation procedures. The blood was drawn into plain sample containers and ethylene diamine tetra-acetic acid (EDTA) container. The blood samples in the plain containers were allowed to stand to clot properly for 1 hour at room temperature. The clot was retracted and the blood was centrifuged at 5000 rpm for 15 minutes. The supernatant (serum) obtained was aspirated into a separate labeled plain sample container. The samples were assayed within 1 hour for the biochemical parameters; Uric acid, albumin, bilirubin, Superoxide dismutase, Catalase (CAT), and Lipid peroxidation product malondialdehyde using spectrophotometric techniques. The blood samples in the EDTA container were analyzed within 1 hours for haematological indices using automated haematology analyzer (Mindray Auto Haematology Analyzer, HM-500X, 2016, Germany)

**2.3 Determination of Haematological Indices**

Hematological indices were analyzed using an automated hematology analyzer (Mindray Auto Hematology Analyzer, HM-500X, 2016, Germany).

Principle: The Beckman Coulter method, which is used for particle sizing and counting, relies on detecting changes in electrical resistance caused by non-conductive particles suspended in an electrolyte solution. As a suspension of blood cells passes through a narrow orifice alongside an electric current, each cell creates an impedance change proportional to its size. The system then counts individual cells and generates a size distribution profile. To enhance accuracy, the number of cells counted per sample is approximately 100 times greater than a conventional microscopic count, reducing statistical error by nearly tenfold.

Procedure: The hematology analyzer was powered on, and the sample ID was entered and verified on the touchscreen display. The blood sample was gently mixed by inverting the tube at least three times. The sample tube was then positioned for aspiration by the analyzer’s probe. Once aspirated, the machine processed the sample, displayed the results on the screen, and printed them out for further analysis [10].

**2.4 Determination of Enzymatic and Non-enzymatic Antioxidants**

Serum superoxide dismutase (SOD) levels were assessed using the direct colorimetric method described by Okutu and Onitsha, (Okutu et al., 2022). Principle: This method is based on the generation of superoxide radicals from xanthine and xanthine oxidase, which interact with 2-(4-iodophenyl)-3-(4-nitrophenyl)-5-phenyltetrazolium chloride, resulting in the formation of a red formazan dye.

Serum catalase (CAT) activity was determined following the direct colorimetric method outlined by Okutu and Onitsha (2022). Principle: This technique relies on the reduction of dichromate to chromic acetate in the presence of hydrogen peroxide (H₂O₂) when heated. The chromic acetate produced is then measured spectrophotometrically at 570 nm.

Serum malondialdehyde (MDA) concentration was estimated using a spectrophotometric method as described by Onitsha and Okutu (2021). Principle**:** MDA forms a conjugate with thiobarbituric acid (TBA), which is separated and measured. Trichloroacetic acid (TCA) is used to precipitate serum proteins, which are then removed by centrifugation. The MDA-TBA complex, which appears pink, is measured at 534 nm.

Total bilirubin (TB) and conjugated bilirubin (CB) were determined using the Jendrassik and Groff method (Jendrassik and Groff, 1938). Principle**:** Sulfanilic acid is converted into a highly reactive diazonium salt through its reaction with nitrous acid, which is generated from sodium nitrite and hydrochloric acid. Conjugated bilirubin (water-soluble bilirubin diglucuronide) reacts with diazotized sulfanilic acid to produce red azobilirubin. Upon adding alkaline tartrate reagent, the red azobilirubin is transformed into a blue azobilirubin with higher absorbance.

Uric acid levels were determined using the Uricase-PAP enzymatic method (Gochman & Schmitz , 1971). Principle: The enzyme uricase converts uric acid into allantoin and hydrogen peroxide. The hydrogen peroxide then reacts with a phenolic compound and 4-aminophenazone in the presence of peroxidase, forming a red quinoneimine dye complex. The intensity of this complex is directly proportional to the uric acid concentration in the sample.

Serum albumin levels were measured using the bromocresol green (BCG) method, as described by Laitinen and Kolthoff (1939). Principle**:** Bromocresol green, a yellow pH indicator at 3.5–4.2, binds specifically to albumin, forming a blue-green complex. The absorbance of this complex is measured at 632 nm, with the intensity of the color being directly proportional to the albumin concentration in the sample.

**2.5 Statistical Analysis**

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS) version 23. Results were presented in tables for clarity. A Student's t-test was conducted to compare the mean values between the test and control groups. Additionally, descriptive statistics such as frequency, mean, standard deviation, and standard error were calculated, along with an unpaired t-test for each parameter. Statistical significance was set at P < 0.05.

**3.0 RESULTS**

Table 1 illustrates that the average age of glaucoma patients was significantly higher (P < 0.05) than that of the control group. Biochemical analysis revealed a significant (P < 0.05) decrease in serum levels of uric acid, total bilirubin, albumin, catalase, and superoxide dismutase in glaucoma patients compared to controls. Conversely, serum malondialdehyde levels were significantly elevated (P < 0.05) in glaucoma patients. However, serum conjugated bilirubin levels showed no significant difference (P > 0.05) between the two groups.

As shown in Table 2, there was no statistically significant difference (P > 0.05) in the mean values of hematological parameters, including packed cell volume (PCV), hemoglobin (Hb), total white blood cell (WBC) count, lymphocytes, neutrophils, monocytes, and platelets, between glaucoma patients and the control group. However, eosinophil levels were significantly lower (P < 0.05) in glaucoma patients compared to controls.

Table 3 further indicates that serum uric acid (U/A), total bilirubin (TB), and conjugated bilirubin (CB) levels were significantly higher (P < 0.05) in male glaucoma patients compared to females. However, albumin (ALB), superoxide dismutase (SOD), and malondialdehyde (MDA) showed no significant difference (P > 0.05) between male and female patients.

Additionally, serum uric acid (U/A) and albumin (ALB) levels showed a slight but significant (P < 0.05) increase with prolonged exposure to glaucoma. However, no correlation was found between the duration of glaucoma exposure and the hematological parameters analyzed in this study.

**Table 1: Comparison of Mean Values of Serum Antioxidants and Malondialdehyde Levels in Glaucoma Patients and Non-glaucomatous Subjects Under Study**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Non-Glaucoma n=30 (X±SD) | Glaucoma n=50(X±SD) | P-Value | Remark |
| U/A (mmol/L | 0.32 ± 0.12 | 0.17 ± 0.06 | 0.001 | S |
| TB (µmol/L | 8.77 ± 2.31 | 7.25 ± 2.11 | 0.027 | S |
| CB (µmol/L | 3.53 ± 1.02 | 2.38 ± 1.31 | 0.010 | S |
| ALB (g/L) | 54.2 ± 4.33 | 40.3 ± 3.03 | 0.001 | S |
| CAT (µl/L) | 56.1 ± 3.74 | 52.5 ± 3.21 | 0.171 | NS |
| SOD (µl/L) | 59.3 ± 4.31 | 52.9 ± 4.01 | 0.135 | NS |
| MDA (nmol/ml) | 3.85 ± 1.21 | 4.01 ± 1.24 | 0.352 | NS |

Results were represented in mean and standard deviation. Student T-test was used for comparing the groups. Keys: S=Significant; NS=Non-significant; MDA=Malonaldehyde; TB=Total bilirubin; CB=Conjugated bilirubin; CAT=Catalase; SOD=Superoxide Dismutase; ALB= Albumin; U/A=uric acid.

**Table 2: Comparison of the Mean Values of Haematological Indices of Glaucoma Patients and Non-glaucomatous Subjects Under Study**

Haematological Glaucoma Patients Non- Glaucoma Patients P- Remark (n=50) (n=30) value

Age (years) 38.33 ± 6.34 33.53 ± 5.32 0.003\* S

PCV (%) 40.5 ± 1.07 41.5 ± 2.23 0.762 NS

Hb (g/dl) 12.78 ± 1.07 12.99 ± 2.23 0.642 NS

TWBC (x 109/L) 7.21 ± 1.07 6.65 ± 1.23 0.182 NS

NEUT (%) 47.35 ± 7.13 44.02 ± 6.04 0.856 NS

LYMP (%) 49.02 ± 5.13 49.05 ± 5.21 0.256 NS

MONO (%) 1.72 ± 0.12 1.99 ± 0.14 0.504 NS

EOSIN (%) 1.02 ± 1.08 4.45 ± 1.21 0.002\* S

PLT(x109/l) 203.45 ± 20.22 231.48 ± 21.43 0.378 NS

Key: Values marked with an asterisk (\*) indicate statistical significance at P < 0.05. Results are presented as Mean ± Standard Deviation (SEM). A Student’s t-test was used for analysis, with P < 0.05 considered statistically significant. 'NS' denotes non-significant results, while 'S' indicates statistical significance. Abbreviations: TWBC – Total White Blood Cell count, NEUT – Neutrophil, LYMP – Lymphocyte, MONO – Monocyte, EOSIN – Eosinophil, and PLT – Platelet.

**Table** **3: Comparison of Serum Antioxidants and Malondialdehyde levels in Glaucoma patients by Gender.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Male (n=21)(X±SD) | Female (n=29)(X±SD) | P-Value | Remark |
| U/A (mmol/L | 0.37 ± 0.11 | 0.24 ± 0.02 | 0.001 | S |
| TB (µmol/L | 8.81 ± 2.23 | 8.07 ± 2.01 | 0.022 | S |
| CB (µmol/L | 3.68 ± 1.42 | 3.17 ± 1.04 | 0.045 | S |
| ALB (g/L) | 40.9 ± 4.00 | 40.7 ± 4.13 | 0.720 | NS |
| CAT (µl/L) | 45.1 ± 3.11 | 45.3 ± 3.21 | 0.241 | NS |
| SOD (µl/L) | 54.1 ± 4.01 | 53.9 ± 4.33 | 0.132 | NS |
| MDA(nmol/ml) | 4.06 ± 1.20 | 4.02 ± 1.10 | 0.751 | NS |

Results were represented in mean and standard deviation. Student T-test was used for comparing the groups. Keys: S=Significant, NS=Non-significant, MDA=Malonaldehyde, TB=Total bilirubin, CB= Conjugated bilirubin, CAT=Catalase, SOD=Superoxide Dismutase, ALB=Albumin, U/A=Uric acid.

**4.0 DISCUSSION**

Glaucoma is a neurodegenerative condition that damages the eye's optic nerve, and when left untreated, may causes irreversible blindness (Steinmetz et al., 2022). It occurs as a result of buildup of intraocular pressure in the optic nerve cells of the eye. According to report, its prevalence is rising and varies globally, and it is projected that the number of glaucoma cases will be higher than 111.8 million people by 2040 (Tham et al., 2014). In Nigeria, glaucoma is reported as the second leading cause of blindness with incidence rate of 19%. The present study evaluated some haematological indices, and enzymatic and non-enzymatic antioxidant levels in glaucoma patients.

Antioxidants function as defense mechanisms for ocular tissues against oxidative stress (Yi-Jen Hsueh et a., 2022). The non-enzymatic antioxidants such as uric acid, albumin, bilirubin, vitamin C, and vitamin E are considered as the main ocular antioxidant’s molecules (Wojcik et al., 2013). According to Das and colleagues, (2017), bilirubin and albumin have antioxidant properties and may be utilized as blood biomarkers for disorders linked to oxidative stress. Previous research has highlighted a decline in serum bilirubin and albumin levels in individuals suffering from neurodegenerative and neuroinflammatory conditions, including multiple sclerosis and Parkinson’s disease (Liu et al., 2008). Erdurmus et al. (2019) also reported a reduction in total antioxidant capacity in patients with primary open-angle glaucoma and pseudoexfoliation glaucoma. Similarly, our study observed a significant decrease in serum albumin, total bilirubin, and conjugated bilirubin levels among glaucoma patients compared to the control group. These findings align with studies by Chong et al. (2022) and Rubia et al. (2022). The results suggest that elevated bilirubin and albumin levels could be linked to intraocular pressure (IOP) regulation and bilirubin-related neurological dysfunction.

Uric acid (UA) plays a vital role as an antioxidant, possessing metal-chelating properties and the ability to neutralize nitrogen radicals and superoxide, thereby preventing the formation of potent oxidants like peroxynitrite (Li et al., 2016). It has been proposed that UA may provide neuroprotection against oxidative stress-related damage (Bowman et al., 2010; Irizarry et al., 2009). In this study, glaucoma patients exhibited significantly lower uric acid levels than the control group. According to Tanito et al. (2012), a decrease in serum UA may contribute to oxidative stress insufficiency, which could be a factor in glaucoma progression. However, this observation contrasts with findings from Yuki et al. (2020) and Li et al. (2019), who reported elevated UA levels in glaucoma patients compared to healthy individuals. Li et al. (2016) found that glaucoma patients had significantly lower UA levels, while Al-Khateeb et al. (2015) documented those individuals with lower baseline UA levels had a higher likelihood of glaucoma progression over time. These results indicate that reduced serum UA levels may serve as a risk factor for glaucoma. Conversely, Yang et al. (2022) found that higher UA levels were associated with reduced retinal capillary plexus vessel density, suggesting a potential detrimental effect on the retinal microvasculature and underscoring the need to regulate UA levels to prevent vascular changes.

Antioxidant enzymes, including superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), and glutathione reductase (GST), play a crucial role in mitigating oxidative stress by eliminating harmful by-products and protecting cells from free radical-induced damage (Wojcik et al., 2013). While some studies have documented reduced total antioxidant capacity in glaucoma patients, our findings revealed no statistically significant difference in serum SOD and CAT levels between the glaucoma and control groups, though a slight reduction was observed in the affected individuals. Malondialdehyde (MDA), an oxidative stress biomarker formed from the peroxidation of polyunsaturated fatty acids such as arachidonic acid, is typically measured as Thiobarbituric Acid Reactive Substances (TBARS). In this study, MDA levels showed no statistically significant difference between glaucoma patients and the control group, though they were marginally higher in the glaucoma group. These results align with Hasan et al. (2017), who found no significant variations in SOD, CAT, and MDA levels between glaucoma patients and controls. However, Ferreira et al. (2004) reported increased SOD and GPx activity in glaucoma patients, with no significant changes in CAT levels.

Our study further revealed that male glaucoma patients had significantly higher serum UA, total bilirubin, and conjugated bilirubin levels compared to female patients (P<0.05). This contradicts the findings of Octavia et al (2012), who suggested that women possess stronger antioxidant defense mechanisms than men, likely due to the protective effects of estrogen, which may enhance resistance to oxidative stress.

Studies on the relationship between glaucoma and hematological indices have yielded conflicting results. Gwyn et al. (1993) noted minimal changes in inflammatory cell counts with age progression in primary glaucoma patients, while Akinlabi and Iyawe (2009) reported eosinopenia (reduction in eosinophil count) in glaucoma patients, with no significant differences in packed cell volume, total, or differential white blood cell counts. Similarly, our study found no notable variations in packed cell volume, hemoglobin levels, total white blood cell count, differential white blood cell count, or platelet count between glaucoma patients and the control group. However, a significant reduction (P<0.05) in eosinophil levels was observed among glaucoma patients. This reduction may be attributed to the use of corticosteroids such as dexamethasone, which is known to suppress eosinophil survival while simultaneously increasing intraocular pressure (Bartlett et al., 1993).

Another possible explanation for eosinopenia in glaucoma patients could be stress, which has been shown to lower eosinophil counts. Elevated intraocular pressure has been linked to psychological stressors, including anxiety, anger, and depression, whereas a decrease in IOP has been associated with states of relaxation and happiness (Akinlabi et al., 2009). Additionally, prostaglandins, which play a role in eosinophil activation, may also contribute to this phenomenon. Prostaglandin analogs like latanoprost are widely used in managing glaucoma by reducing IOP (Mannini et al., 2007).

**5.0 Conclusion**

This study has demonstrated a significant decline in serum albumin, total bilirubin, conjugated bilirubin, and uric acid levels in glaucoma patients compared to healthy individuals. These findings suggest that oxidative stress exposure alters antioxidant levels, potentially contributing to increased intraocular pressure and optic nerve damage, which could ultimately result in vision loss. Additionally, the observed relationship between glaucoma and eosinophil levels suggests that eosinopenia could be a potential risk factor for the disease. Further large-scale investigations are recommended to establish a more definitive link between eosinophil levels and glaucoma.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**CONSENT**

A written informed consent was obtained from all participants before their enrollment into the study

**ETHICAL APPROVAL**

Prior to the study, ethical approval was obtained from the Research and Ethical Committee of Niger Delta University Teaching Hospital, Okolobiri, Yenagoa, Bayelsa State.

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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