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Relationship Between Antioxidant Vitamins and Glycated Haemoglobin in Preeclampsia

Nnodim Johnkennedy[1]*, Ozoemena Chimaoge Covenant[2]

[1]*Department of Medical Laboratory Science, Imo State University, Owerri, Imo State, Nigeria.* [2]*Department of Chemical Pathology, Faculty of Medical Laboratory Science, Federal University Otuoke, Bayelsa State, Nigeria.*

**Corresponding author: Nnodim Johnkennedy.*

Abstract

Preeclampsia is a pregnancy related hypertension condition marked by endothelial dysfunction, oxidative stress, and metabolic changes that may influence glycaemic status. This study aimed to assess the concentrations of antioxidant vitamins C and E, together with glycated haemoglobin (HbA1c), in women with preeclampsia in comparison to normotensive pregnant women. This study recruited 150 pregnant women aged 18 to 40 years, including 75 diagnosed with preeclampsia and 75 normotensive pregnant women serving as controls. Individuals with pre-existing diabetes or other metabolic problems were excluded. We took four milliliters (4 ml) of fasting venous blood from each person. Standard biochemical procedures were used to find the amounts of vitamins C and E in plasma, and ion-exchange resin methods were used to find the levels of glycated haemoglobin. Statistical analysis utilised Student's t-test, establishing significance at $p < 0.05$. The findings indicated that the concentrations of vitamins C and E were markedly decreased in women with preeclampsia relative to normotensive controls ($p < 0.05$). On the other hand, glycated haemoglobin levels were much higher in preeclamptic individuals than in controls ($p < 0.05$). The results indicate that oxidative stress, as demonstrated by diminished antioxidant vitamins, and modified glycaemic state may significantly contribute to the pathogenesis of preeclampsia. Supplementation with antioxidants and monitoring of metabolic parameters may be advantageous in the therapy of preeclampsia.

Keywords: antioxidant vitamins; glycated haemoglobin; preeclampsia; oxidative stress; pregnancy

Introduction

Preeclampsia is a multisystem illness of pregnancy marked by the emergence of hypertension and proteinuria after 20 weeks of gestation. It continues to be one of the primary causes of maternal and perinatal morbidity and mortality globally, especially in developing nations where access to appropriate prenatal care may be restricted [1]. In a clinical setting, preeclampsia manifests as high blood pressure and proteinuria, with severe instances leading to consequences such as eclampsia, HELLP syndrome (characterised by haemolysis, elevated liver enzymes, and reduced platelet count), and multi-organ failure. These difficulties substantially impact negative maternal and foetal outcomes, including preterm birth, intrauterine growth restriction, and an elevated risk of cardiovascular disorders in later life [2].

The pathophysiology of preeclampsia is intricate and not fully elucidated, despite the proposal of various pathways. A prevalent notion posits that defective placentation in early pregnancy results in insufficient trophoblastic invasion of the maternal spiral arteries. This leads to less blood flow to the uterus and placenta, which is called placental ischaemia. As a result, more antiangiogenic agents, inflammatory mediators, and reactive oxygen species (ROS) are released into the mother's blood. All of these things make systemic endothelial dysfunction worse [3]. Endothelial dysfunction is fundamental to the clinical features of preeclampsia, encompassing hypertension, heightened vascular permeability, and the activation of the coagulation cascade.

Oxidative stress is a very important part of how preeclampsia starts and gets worse. It results from a disparity between the generation of reactive oxygen species and the body's antioxidant defence systems. During a normal pregnancy, oxidative stress increases because metabolism and mitochondrial function are working harder [4]. But this is usually balanced off by an increase in antioxidant systems. In preeclampsia, this equilibrium is disturbed, resulting in heightened oxidative stress. The placenta is a large producer of free radicals, such as superoxide anions, hydrogen peroxide, and hydroxyl radicals. These can harm lipids, proteins, and DNA [5]. Lipid peroxidation, in particular, has been linked to damage to the endothelium and problems with blood vessels, which makes the condition worse.

Pregnant women with preeclampsia are especially susceptible to oxidative injury because of heightened

lipid peroxidation and diminished antioxidant capacity. Vitamin C (ascorbic acid) and vitamin E (α-tocopherol) are two antioxidant vitamins that are very important for the body's defence against oxidative stress. Vitamin C is an antioxidant that dissolves in water and picks up free radicals in the watery parts of cells and plasma. It also helps vitamin E go back to its original form. Vitamin E, on the other hand, is an antioxidant that dissolves in lipids and stops free radical chain reactions from damaging cell membranes [6]. These vitamins work together to keep cells healthy and protect them from damage caused by free radicals. A lack of these antioxidants may make endothelial dysfunction worse and play a big role in the pathogenesis of preeclampsia [7].

Multiple studies indicate diminished levels of antioxidant vitamins in women with preeclampsia, implying greater consumption due to elevated oxidative stress. This depletion may hinder the body's capacity to neutralise reactive oxygen species, resulting in additional cellular damage and exacerbation of clinical symptoms. Oxidative stress has also been demonstrated to cause the release of pro-inflammatory cytokines and adhesion molecules, which makes vascular injury worse and makes the disease worse. Consequently, antioxidant status is a significant determinant in comprehending the evolution and management of preeclampsia [8].

Along with oxidative stress, changes in metabolism, especially those that affect how glucose is used, have been linked to the development of preeclampsia. Glycated haemoglobin (HbA1c) is a common biomarker that shows what the average blood sugar levels have been over the last 2-3 months. It is produced via the non-enzymatic glycation of haemoglobin and is frequently utilised in the diagnosis and monitoring of diabetes mellitus. However, its significance in pregnancy, particularly in situations like preeclampsia, has garnered heightened scrutiny in recent years [9].

High HbA1c readings during pregnancy may be a sign of subclinical hyperglycemia, insulin resistance, or poor glucose tolerance. All of these things can make it more likely that a woman would have high blood pressure during pregnancy. Insulin resistance is recognised as a factor that exacerbates endothelial dysfunction by facilitating inflammation, oxidative stress, and vascular rigidity. In preeclampsia, these effects may exacerbate pre-existing vascular anomalies, consequently deteriorating clinical outcomes [10]. Additionally, hyperglycemia can exacerbate oxidative stress by elevating the development of advanced glycation end products (AGEs), which further compromise endothelial cells and disrupt vascular function.

The relationship between oxidative stress and abnormal glucose metabolism is crucial for comprehending the pathophysiology of preeclampsia. Antioxidant depletion signifies an augmented oxidative burden, whilst raised HbA1c may signify underlying metabolic dysregulation. These factors may work together to make endothelial dysfunction and disease progression worse. Nonetheless, there is insufficient data about the concurrent evaluation of antioxidant vitamins and glycated haemoglobin in preeclamptic patients, especially in resource-constrained environments [11].

Due to the significant impact of preeclampsia and its related problems, there is a want for enhanced comprehension of its fundamental mechanisms and prospective biomarkers for early identification and intervention. Assessing the correlation between antioxidant vitamins and glycated haemoglobin may yield significant insights into the roles of oxidative stress and metabolic changes in this disease. This information could also help in the creation of treatment plans, such as taking antioxidant supplements and controlling metabolism, that aim to lessen the severity of the condition and improve outcomes for both the mother and the fetus [12].

Therefore, this study aims to evaluate the relationship between antioxidant vitamins (C and E) and glycated haemoglobin in women with preeclampsia, with a view to elucidating their roles in the pathogenesis of the disorder and their potential utility in clinical management.

Materials and Methods

Subjects

A total of 150 pregnant women aged 18-40 years were recruited for this study. This included 75 women diagnosed with preeclampsia and 75 normotensive pregnant women serving as controls. Subjects with diabetes mellitus, chronic hypertension, or other metabolic disorders were excluded. Ethical approval was obtained from the hospital ethics committee Specialist Hospital Owerri, and informed consent was obtained from all participants.

Blood Collection

Four milliliters (4 ml) of fasting venous blood was collected from each subject into plain and EDTA

containers. Serum was separated by centrifugation at 5,000 g for 5 minutes.

Biochemical Assay

Plasma vitamin C was assayed by the 2,4-dinitrophnyl hydrazine method. The vitamin E was estimated based on its ability to reduce ferric ions to ferrous ions, forming a coloured complex with α-dipyridyl. Glycated haemoglobin was measured using the ion-exchange resin method.

Statistical Analysis

The results were expressed as mean ± standard deviation and student t-test was used to calculate the level of significance at $p < 0.05$.

Results

Group	Vitamin C (mg/dl)	Vitamin E (mg/dl)	Glycated H. (%)
Normotensive Pregnant Women	0.90±0.08	1.71±0.18	5.81±0.93
Preeclamptic Women	0.72±0.07*	1.21±0.08*	5.01±0.61*

**Significantly different from control at P<0.05.*

Discussion

Preeclampsia is a multifaceted condition of pregnancy characterised by heightened oxidative stress and metabolic abnormalities, both of which are integral to its pathogenesis. This study revealed that antioxidant vitamins C and E were significantly diminished in preeclamptic women compared to normotensive pregnant controls. This observation aligns with the prevalent notion that preeclampsia is marked by a disparity between pro-oxidant and antioxidant systems, resulting in oxidative stress that exacerbates endothelial dysfunction and clinical illness presentation [13].

The observed deficiency of antioxidant vitamins in preeclamptic individuals may be ascribed to heightened consumption of these antioxidants in an effort to counteract elevated reactive oxygen species (ROS) produced during oxidative stress. In a normal pregnancy, oxidative metabolism rises because the placenta and mother's tissues are more active. In preeclampsia, improper placentation causes the placenta to be perfused only sometimes, which causes ischemia-reperfusion damage. This mechanism is a big reason why ROS are generated, like superoxide anions, hydrogen peroxide, and hydroxyl radicals. The body can't keep up with the high levels of free radicals, which depletes important antioxidant minerals like vitamins C and E [14].

Vitamin C (ascorbic acid) is a key water-soluble antioxidant that helps protect cells from oxidative damage. It works by directly removing free radicals from water-based biological settings and by restoring other antioxidants, such vitamin E, to their active forms. Vitamin C also helps keep the endothelium healthy and helps make collagen, which is important for keeping blood vessels stable. The reduced vitamin C levels identified in this study indicate heightened oxidative consumption and inadequate dietary or physiological replenishment in women with preeclampsia [15].

Vitamin E (α-tocopherol), a lipid-soluble antioxidant, serves as a principal protector against lipid peroxidation in biological membranes. It stops free radical chain reactions, which protects polyunsaturated fatty acids in cell membranes from breaking down. Lipid peroxidation is a crucial process in preeclampsia that leads to endothelial cell injury, heightened vascular permeability, and hypertension. The substantial decrease in vitamin E levels identified in this study signifies a weakened lipid-phase antioxidant defence, potentially increasing susceptibility to vascular damage and disease progression [16].

The simultaneous decrease in vitamins C and E indicates a compromised antioxidant defence mechanism in women with preeclampsia. This deficit may worsen endothelial dysfunction, which is a key factor in the development of preeclampsia. Endothelial dysfunction results in compromised vasodilation, elevated vascular resistance, platelet activation, and a pro-inflammatory state, all of which contribute to the clinical manifestations of hypertension and proteinuria. Oxidative stress has also been demonstrated to activate inflammatory pathways and stimulate the release of antiangiogenic substances, which makes the function of the placenta and the whole body even worse [17].

This study demonstrated that glycated haemoglobin (HbA1c) levels were considerably higher in preeclamptic women than in normotensive controls, in addition to oxidative stress. HbA1c is a well-known biomarker for long-term glycaemic management. It shows the average blood sugar levels over a period of about 8 to 12 weeks. In preeclampsia, high HbA1c

readings indicate that glucose metabolism has changed, insulin resistance has developed, or hyperglycaemia is present without any obvious signs of diabetes mellitus.

This discovery is consistent with increasing evidence that metabolic imbalance significantly contributes to the pathogenesis of preeclampsia. Insulin resistance has been associated with endothelial dysfunction via several pathways, including elevated oxidative stress, augmented inflammatory responses, and reduced nitric oxide bioavailability. These consequences together cause blood vessels to not work properly and blood pressure to rise, which are two of the main signs of preeclampsia [19].

Hyperglycemia is also known to cause oxidative stress in a number of ways, such as by increasing the generation of reactive oxygen species (ROS) in mitochondria and the creation of advanced glycation end products (AGEs). AGEs can attach to their receptors (RAGE) on endothelial cells, which starts inflammatory cascades and further oxidative damage. This sets off a vicious cycle in which oxidative stress makes metabolic problems worse, and metabolic problems make oxidative stress worse. The increased HbA1c noted in this study may not only indicate altered glucose metabolism but also directly contribute to endothelial damage in preeclampsia [20].

The simultaneous presence of diminished antioxidant vitamins and increased HbA1c underscores a notable interaction between redox imbalance and metabolic abnormalities in preeclampsia. These two pathogenic processes may work together to make endothelial dysfunction and disease severity worse. Oxidative stress diminishes antioxidant reserves, while metabolic dysregulation exacerbates free radical generation, establishing a self-sustaining cycle of vascular damage. This dual process may elucidate the increasing characteristics of preeclampsia and its related complications [21].

The results of this study align with prior research indicating reduced antioxidant levels and modified metabolic indicators in preeclamptic women. Nevertheless, the joint evaluation of antioxidant vitamins and glycated haemoglobin yields a more thorough comprehension of the biochemical modifications linked to the disease. It also indicates that oxidative stress and metabolic dysfunction must be regarded in the assessment and treatment of preeclampsia [22].

These discoveries hold significant clinical implications. Regular checks of pregnant women's antioxidant levels and blood sugar levels may assist find women who are more likely to get preeclampsia or its complications. Early identification of oxidative imbalance and metabolic changes may provide prompt interventions to enhance maternal and foetal outcomes. Adding antioxidant vitamins to the diet, especially vitamins C and E, may help restore redox equilibrium and lower oxidative damage. However, further clinical trials are needed to prove their effectiveness [23].

Likewise, monitoring and managing glycaemic status during pregnancy, even in non-diabetic women, may help lower the risk or severity of preeclampsia. Changes in lifestyle, nutrition, and constant monitoring of metabolism may help lower insulin resistance and the problems it causes in the blood vessels [24].

Conclusion

This study shows that women with preeclampsia have far lower levels of antioxidant vitamins C and E and much higher amounts of glycated haemoglobin than women with normal blood pressure. These findings indicate that oxidative stress and modified glycaemic state are significant and interconnected factors in the aetiology of preeclampsia. The depletion of antioxidant vitamins signifies a weakened antioxidant defence system, but an elevated HbA1c level implies underlying metabolic abnormalities that may lead to endothelial dysfunction. The coexistence of these anomalies underscores the synergistic interplay between oxidative stress and metabolic imbalance in preeclampsia. Consequently, regular evaluation of antioxidant levels and glycaemic indicators during pregnancy, in conjunction with suitable dietary supplementation and metabolic regulation techniques, may enhance the early identification, prevention, and management of preeclampsia. Additional extensive investigations are advised to investigate the therapeutic efficacy of antioxidant and metabolic therapies in alleviating the burden of this illness.

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