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Evaluation of Plasma Selenium, Zinc and Malondialdehyde Levels in Newly Diagnosed Preeclamptic Women at A Teaching Hospital

Obianuju U Ilechukwu[1] **Jude A Onuegbu**[2] **Japhet M Olisekodiaka**[2] **Chikaodili N Obi-Ezeani**[1]
[1]*Department of Chemical Pathology, Chukwuemeka Odumegwu Ojukwu University, Awka, Anambra State, Nigeria*
[2]*Department of Chemical Pathology, Nnamdi Azikiwe University, Nnewi, Anambra State, Nigeria*

Introduction: Preeclampsia is a clinical condition unique to humans which forms a major part of hypertensive disorders in pregnancy. Although its exact etiology remains unknown, an imbalance between lipid peroxides and antioxidants is implicated. The study aimed to evaluate plasma selenium, zinc, and malondialdehyde (MDA) levels in newly diagnosed preeclamptic women attending antenatal visits at Chukwuemeka Odumegwu Ojukwu University Teaching Hospital (COOUTH), Awka in Anambra State.
Materials and Methods: A total of 81 female participants were recruited and grouped into three (A, B, and C) comprising 21 newly diagnosed preeclamptic women, 30 healthy pregnant control, and 30 non-pregnant control participants respectively.
Results: The newly diagnosed preeclamptics had significantly lower plasma selenium levels when compared with the healthy pregnant and non-pregnant controls ($p<0.05$). The plasma zinc level in the preeclamptics did not differ significantly from the level in healthy pregnant women ($p>0.05$), it was however significantly lower in the preeclamptics and healthy pregnant women when compared with the non-pregnant women ($p<0.05$). Plasma MDA level was significantly elevated in the preeclamptics compared to the healthy pregnant and non-pregnant control participants ($p<0.05$).
Conclusion: Newly diagnosed preeclamptics have lower plasma selenium and zinc levels with higher plasma MDA levels, and additional sources of these micronutrients may be required.
Keywords: Preeclampsia, pregnancy, selenium, zinc, malondialdehyde

Introduction

Preeclampsia is a human pregnancy specific disorder which forms a major part of hyper tensive disorders (1). It presents with elevation of blood pressure to ≥140/90 mmHg and significant proteinuria of ≥0.3g/day or ≥30mg /mmol of urinary creatinine in random sample after 20 weeks of gestational age (2). It may as well occur as late as 4 - 6 weeks postpartum (3). It is a major cause of long term maternal and perinatal mortality and morbidity worldwide (4, 5). In as much as preeclampsia remains a threat to pregnancy, its exact aetiology and pathophysiology remains unknown.

Corresponding Author: Chikaodili Nwando Obi-Ezeani, MD Chemical Pathology, Chukwuemeka Odumegwu Ojukwu University, Awka, Anambra State, Nigeria
E-Mail: femmenatura@yahoo.com
ORCID: 0000-0002-9581-0051
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Malondialdehyde (MDA), which is a product of lipid peroxidation has been reported to be increased in certain disease conditions including preeclampsia (6, 7) which could lead to oxidative stress. Antioxidant trace elements such as selenium and zinc are essential elements incorporated into antioxidants enzymes like glutathione peroxidase and superoxide dismutase respectively to prevent oxidative stress. Meanwhile, studies have shown conflicting reports on levels of blood trace elements in preeclampsia (8-10). Preeclampsia affects women in developing countries more than women in developed nations (11), and Nigeria is known to be among the six countries in the world with very high maternal mortality rate due to preeclampsia (12). Worst still, preeclampsia and eclampsia are shown to be the leading cause of maternal mortality in Nigeria (13).

This study was therefore aimed at evaluating plasma levels of MDA and some antioxidant trace elements: selenium and zinc in preeclamptics attending antenatal visits at Chukwuemeka Odumegwu Ojukwu University Teaching Hospital in Awka, Anambra State, South East Nigeria.

Materials and Methods

Participants

This case control study evaluated the plasma levels of Selenium, Zinc and MDA in newly diagnosed preeclamptic women who have not commenced antihypertensive medications attending antenatal visits at Chukwuemeka Odumegwu Ojukwu University - Teaching Hospital (COOUTH), Awka in Anambra State from June to December 2019.

A total of 81 female participants were recruited for this study and divided into three groups (A, B and C) which comprised of 21 newly diagnosed preeclamptic women (group A), 30 pregnant control participants (group B) and 30 non-pregnant control participants (group C) .

Participants aged between 20 and 35 years, preeclamptic women with minimum blood pressure of 150/100 mmHg, pregnant and non-pregnant women with normal blood pressures (<140/90 mmHg) were recruited for the study.

Pregnant women with the following conditions were excluded: chronic hypertension, diabetes mellitus, thyroid diseases, liver diseases, kidney diseases and other metabolic disorders, mild hypertension, patients on mineral supplements, herbal medications and anti-hypertensives. Pregnant women with previous history of preeclampsia or eclampsia, pregnant women who did not book before 20 weeks of gestational age. Women who smoked or consumed alcohol at any gestational age of pregnancy or women with BMI>30kg/m^2.

Ethical Statement

The ethical approval for this study was issued by the Ethics Committee COOUTH, Awka, Anambra state, Nigeria. Written informed consents were sought after brief explanation of the purpose of this study, and they freely signed up to participate.

Sample Collection

Five milliliters (5 ml) of random blood samples were collected from ante-cubital vein of each participant under aseptic conditions into lithium-heparin bottle. Each blood sample was centrifuged, at 3000 revolutions per minute for 5 minutes, immediately after collection at the Chemical Pathology Laboratory COOUTH. The plasma were separated into plain tubes and stored at –20^{o}C until required for analysis. All analyses were done within two weeks of sample collection. Pregnant participants were tested for

significant proteinuria using Combi 9 strips dipped in their early morning midstream urine collected in a clean universal container. Pregnancy was ruled out in non-pregnant participants by choronic gonadotrophin strips.

Laboratory Procedures

Selenium and zinc levels were determined by Atomic Absorption Spectrophotometer (AAS) according to the method of American Public Health Association (14) while MDA level was determined according to the method of Gutteridge and Wilkins (15).

Statistical Analysis

Statistical Package for Social Sciences (SSPS) version 23.0 (SPSS Inc, Chicago, IL, USA) was used in analysis of data. The results were expressed in mean±standard deviation. One way analysis of variance (ANOVA) was used for comparison of means among the three groups, post-hoc analysis was used to determine the intergroup variability, and p value<0.05 was considered to be statistically significant.

Results

The result of this study (Tables 1&2) showed that the newly diagnosed preeclamptic women had significantly lower mean plasma level of selenium when compared to the pregnant and non-pregnant control participants (p=0.024 and 0.0001 respectively). The pregnant control also had significantly lower plasma selenium level when compared to the non-pregnant controls (p=0.0001).

There was no significant difference in the mean plasma zinc level in the newly diagnosed preeclamptic women compared to the pregnant controls (p=0.053), however, this was significantly reduced in the newly diagnosed preeclamptics when compared to the non-pregnant control participants (p=0.0001) as well as in the pregnants when compared to the non-pregnant control participants (p=0.003). The mean plasma MDA level was significantly elevated in the newly diagnosed preeclamptics in comparison to the pregnant and non-pregnants (p=0.003 and p=0.0001 respectively), however, there was no significant difference in the level of this parameter in pregnant controls when compared to the non-pregnant control participants (p=0.61).

Discussion

Preeclampsia is a life threatening complication of pregnancy which may threaten the lives of mother and/or fetus. The lower plasma selenium levels observed in preeclamptics as well as in healthy pregnant control participants

Table 1. Plasma Levels of Selenium, Zinc and MDA among study participants

Parameters	Groups				
	A (n=21)	B (n=30)	C (n=30)	F	*p-value*
Selenium *(µg/l)*	44.29±13.07	53.67±11.68	86.63±11.79	91.27	0.0001*
Zinc *(µg/dl)*	74±15.59	88.97±17.74	107.9±28.03	15.55	0.0001*
MDA *(nmol/ml)*	2.83±0.9	1.96±0.63	1.66±0.51	11.05	0.0001*

Table 2. Post-hoc test showing mean differences and p-values of study groups

Parameters	Mean Difference			p-value		
	A vs B	A vs C	B vs C	A vs B	A vs C	B vs C
Selenium *(µg/l)*	-9.38	-42.35	-32.97	0.024*	0.0001*	0.0001*
Zinc *(µg/dl)*	-14.97	-33.9	-18.93	0.053	0.0001*	0.003*
MDA *(nmol/ml)*	0.87	1.16	0.29	0.003*	0.0001*	0.61

may be associated with placental transfer of selenium from the mother to the developing fetus (16) as well as hemodilution resulting from increased plasma volume in pregnancy. This is in line with previous studies which also reported lower plasma selenium levels in preeclamptics (17, 18) and healthy pregnant women (19). Karita et al. (20) however reported otherwise. Venderlelie and Perkin (18) had earlier reported that an average selenium level of ≥95ug/l is required for optimal activity of the antioxidant enzyme, glutathione peroxidase (GPx), and from this study, the average plasma selenium level of preeclamptics and healthy pregnant women are suboptimal for glutathione peroxidase function. This may result to increased production of reactive oxygen species (ROS) and oxidative stress.

In this study, plasma level of zinc was also significantly lower in preeclamptics compared to the non-pregnant control participants as well as in pregnant participants compared to non-pregnant participants, and this may as well be attributed to placental transfer to the growing fetus (21, 22). This is supported by studies which reported higher plasma zinc levels in fetuses compared to their mothers (23). This decrease may also be as a result of increase in plasma volume which in turn reduces plasma zinc concentration (24). Additionally, the low plasma zinc levels may be partly due to increase in urinary excretion of zinc in preeclamptics (25), and serum cortisol which is known to increase during normal pregnancy, with a much higher level in preeclampsia may as well stimulate increased zinc excretion (26). Similarly, supplemental iron of ≥65mg per day of elemental iron may decrease intestinal zinc absorption (27) or limit its bioavailability because both zinc and iron have same plasma carrier protein, transferrin. Hambidge et al. (28) showed that iron therapy in doses typically prescribed by obstetricians has an acute measurable effect on maternal zinc status.

Our findings agree with the respectively reported lower levels of zinc in preeclamptics compared with non-pregnant women in Bangladesh, Saudi Arabia and India (29, 30, 10). Our finding however differs from those of Golmohammad et al. (31) and Ugwuja (32) who did not observe any significant difference in the plasma zinc levels between the preeclamptics and controls. Zinc is an essential component of the antioxidant enzyme, superoxide dismutase (SOD) involved in the removal of free radicals or ROS (33), and as such, reduction in the level of this essential element may cause insufficiency of SOD (34) thereby exposing pregnant women to oxidative stress, which may lead to the development of preeclampsia.

The elevated plasma level of MDA in preeclamptics may be due to increased generation of reactive oxygen species (ROS) which could lead to lipid peroxidation. This is consistent with reports beyond Nigeria (35)(7) and within Nigeria (36). Guptha et al. (37) however, did not demonstrate any significant difference between preeclamptics and non-pregnant controls.

Conclusion

This study suggests that preeclamptic women have lower plasma concentrations of zinc and selenium and higher MDA concentration compared to healthy pregnant and non-pregnant women. Therefore pregnant women in this environment (Nigerian Africans), especially those at high risk of developing preeclampsia, should take zinc and selenium rich diets.

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Contact Details

Obianuju Uchenna Ilechukwu, MD
Department of Chemical Pathology, Chukwuemeka Odumegwu Ojukwu University, Awka, Anambra State, Nigeria
E-Mail: uju.ilechuwu@gmail.com
ORCID: 0000-0001-9645-0871

Jude Anaelechi Onuegbu, MD
Department of Chemical Pathology, Nnamdi Azikiwe University, Nnewi, Anambra State, Nigeria
E-Mail: ja.onuegbu@unizik.edu.ng
ORCID: 0000-0001-7342-9949

Japhet Madu Olisekodiaka, MD
Department of Chemical Pathology, Nnamdi Azikiwe University, Nnewi, Anambra State, Nigeria
E-Mail: jm.olisekodiaka@unizik.edu.ng
ORCID: 0000-0003-2487-1233

Chikaodili Nwando Obi-Ezeani, MD
Department of Chemical Pathology, Chukwuemeka Odumegwu Ojukwu University, Awka, Anambra State, *E-Mail:* Nigeria
femmenatura@yahoo.com
ORCID: 0000-0002-9581-0051

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