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# Assessment of Micronutrients, Cortisol and Blood Pressure in Pregnant Women Attending a Healthcare Facility

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**Background:** The study aims to assess serum iron, zinc, and selenium concentrations, cortisol levels, and blood pressure measurements in pregnant and non-pregnant women, and to examine variations in these parameters among pregnant women by maternal age, trimester of gestation, and adherence to routine antenatal medication.

**Materials and Methods:** In this cross-sectional study conducted at Iyi-Enu Mission Hospital, 102 pregnant and 80 age-matched non-pregnant women (18–43 years). Fasting serum iron, zinc, and selenium were measured by atomic absorption spectrophotometry, cortisol was measured by competitive ELISA, and blood pressure was measured using a sphygmomanometer. Pregnant participants were further stratified by age group (18–26, 22–35, 36–43 years), trimester (first, second, third), and adherence to routine antenatal medications (always vs. not always).

**Results:** Compared to controls, pregnant women exhibited lower levels of serum iron ( $49.7 \pm 15.2$  vs.  $69.6 \pm 10.9$   $\mu\text{g/dL}$ ), zinc ( $60.1 \pm 10.6$  vs.  $76.3 \pm 8.1$   $\mu\text{g/dL}$ ), and selenium ( $81.2 \pm 20.4$  vs.  $101.4 \pm 14.9$   $\mu\text{g/L}$ ), higher cortisol ( $208.5 \pm 53.8$  vs.  $152.6 \pm 36.8$   $\text{ng/mL}$ ) and elevated systolic and diastolic blood pressures ( $p < 0.05$ ). Within the pregnant group, no differences were observed by age or trimester ( $p > 0.05$ ). Medication adherence did not affect micronutrient or blood pressure, however, the always-adherent women had higher cortisol than those who are not adherent ( $p = 0.047$ ).

**Conclusions:** Pregnancy drives substantial changes in micronutrient levels, cortisol, and blood pressure in this population, whereas maternal age, gestational stage, and routine medication adherence exert minimal influence. These findings highlight the importance of targeted nutritional and clinical monitoring during antenatal care.

**Keywords:** Selenium, zinc, iron, pregnancy, cortisol, blood pressure

## Introduction

Micronutrient deficiencies represent a critical global public health challenge, particularly among pregnant women in low- and middle-income countries. Iron deficiency anemia affects approximately 37% of pregnant worldwide reflecting substantial gaps in hemoglobin

synthesis and oxygen transport capacity (1). In some regions, multiple micronutrient deficiency and anemia prevalence among expectant mothers exceed 50%, with concurrent deficits in zinc and selenium observed across trimesters (2), exacerbating risks for adverse outcomes.

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These deficits have been consistently linked to maternal morbidity, including anemia and hemorrhage, and to negative fetal endpoints such as preterm birth, low birth weight, and impaired neurodevelopment (3).

Iron mineral is indispensable for fetal neurodevelopment: it underpins neurotransmitter synthesis, myelination, cellular differentiation in the developing brain and early-life iron underloading has been shown to produce long-term neurobehavioral deficits (4). Zinc functions in cell proliferation, DNA replication and immune competence. Maternal zinc deficiency is associated with fetal growth restriction, congenital anomalies, and a small but significant increase in preterm birth risk (5). Selenium, as a cofactor for glutathione peroxidases and other selenoproteins, is vital for antioxidant defense in both mother and fetus; low maternal selenium may depict oxidative stress as can be found in preeclampsia (6).

Cortisol, the primary glucocorticoid secreted by the maternal adrenal cortex, increases throughout pregnancy due to elevated corticosteroid-binding globulin levels and heightened hypothalamic pituitary axis (HPA) activity. Hypertensive disorders remain a leading cause of maternal and perinatal mortality. Hypertensive disorders of pregnancy constitute a leading cause of maternal and perinatal mortality worldwide (7).

In Nigeria, few studies have concurrently evaluated the full spectrum of micronutrient status, cortisol levels, and blood pressure in pregnant women. Understanding the interplay between micronutrient status, maternal cortisol, and blood pressure is essential for tailoring interventions to optimize both maternal and fetal health outcomes in this region. Therefore, this study aims to assess and compare serum iron, zinc, and selenium concentrations, cortisol levels, and blood pressure measurements in pregnant and non-pregnant women, and to examine variations in these parameters among

pregnant women by maternal age group, trimester of gestation, and adherence to routine antenatal medication.

## **Materials and methods**

### ***Study Design and Setting***

A hospital-based cross-sectional study was conducted at Iyi-Enu Mission Hospital, Ogidi, Anambra State, Nigeria, between January and July 2023. Pregnant women attending the antenatal clinic and age-matched non-pregnant controls were recruited for the study.

### ***Subjects***

This comprised 102 pregnant and 80 non-pregnant women, aged 18–43 years, who were recruited by simple random sampling from the sampling frame of all consenting attendees during the study period. Consenting females with no chronic illnesses (e.g., diabetes, hypertension, etc.) were included in the study, while those on antihypertensive therapy, micronutrient supplements, or glucocorticoids were excluded from the study.

### ***Sample Collection***

Fasting venous blood (5 mL) was drawn from the antecubital vein into plain tubes, allowed to clot at room temperature for 30 minutes, and centrifuged at 3000g for 5 minutes. Sera obtained were used for biochemical analyses.

### ***Biochemical Assays***

Serum iron, zinc, and selenium concentrations were measured using atomic absorption spectrophotometry following standardized protocols according to the method of American Public Health Association (8). Cortisol was measured by enzyme-linked immunosorbent assay (ELISA) kit (Abcam, ab108665) according to the manufacturer's instructions.

### ***Blood Pressure Measurement***

Systolic and diastolic blood pressures were obtained in the seated position after a 5-minute rest by sphygmomanometer and stethoscope. The cuff was positioned at heart level, with readings taken twice at 1-minute intervals and

averaged for analysis, following international recommendations for manual blood pressure measurement (9).

### Participants Stratification

Pregnant participants were stratified into 3 groups; based on age (18–26 years, 22–35 years, and 36–43 years), gestational stage; (first ( $\leq 13$  weeks), second (14–27 weeks), and third ( $\geq 28$  weeks) trimesters), and self-reported adherence to routine antenatal medications (“always adherent” and “not always adherent”).

### Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of the School of Medical Laboratory Technicians, Iyi-Enu Mission Hospital, Ogidi, Anambra State, and all participants provided written informed consent prior to enrollment. All procedures were according to 1975 Helsinki Declaration.

### Statistical Analysis

Data were analyzed by Statistical Package for Social Sciences (Chicago, IL, USA) v25. Variables were presented as mean $\pm$ SD. Independent-samples t-tests were used to compare two independent variables, one-way analysis of variance (ANOVA) was used to compare means across variables, and a post-hoc test was employed for pairwise comparisons. A p-value of  $<0.05$  was considered significant.

## Results

In Table 1, the pregnant group demonstrated significantly lower levels of iron, zinc, and selenium compared to the non-pregnant group ( $p=0.0001$ ). Additionally, cortisol levels were higher in the pregnant group compared to the non-pregnant group ( $p=0.0001$ ). Additionally, the systolic and diastolic blood pressure values were lower in the pregnant women compared to their non-pregnant counterparts ( $p=0.0002$ ).

In Table 2, no significant differences ( $p>0.05$ ) were observed in micronutrients, cortisol, and blood pressure across the age brackets (18–26 years, 22–35 years, and 36–43 years).

**Table 1.** Micronutrients, Cortisol and Blood Pressure of Pregnant and Non-Pregnant Women

| Parameters                     | Pregnant          | Non-Pregnant       | p-value |
|--------------------------------|-------------------|--------------------|---------|
| Iron ( $\mu\text{g/dL}$ )      | 49.6 $\pm$ 15.22  | 69.62 $\pm$ 10.9   | 0.0001  |
| Zinc ( $\mu\text{g/dL}$ )      | 60.12 $\pm$ 10.59 | 76.34 $\pm$ 8.11   | 0.0001  |
| Selenium ( $\mu\text{g/L}$ )   | 81.2 $\pm$ 20.39  | 101.44 $\pm$ 14.93 | 0.0001  |
| Cortisol ( $\text{ng/mL}$ )    | 208.5 $\pm$ 53.8  | 152.6 $\pm$ 36.82  | 0.0001  |
| Systolic BP ( $\text{mmHg}$ )  | 115 $\pm$ 11.34   | 120.2 $\pm$ 10.79  | 0.0016  |
| Diastolic BP ( $\text{mmHg}$ ) | 75.59 $\pm$ 7.85  | 80.16 $\pm$ 8.15   | 0.0002  |

Data are presented as mean $\pm$ standard deviation. BP: blood pressure. Statistical comparisons were performed using independent sample t-tests. Significant differences were observed between pregnant and non-pregnant groups for all parameters evaluated ( $p<0.05$ ).

The comparison across pregnancy trimesters also yielded no significant differences ( $p>0.05$ ), as shown in Table-3. Among the pregnant women, cortisol was higher in those who reported always adhering to their routine medications compared to those who did not always take their routine drugs ( $p=0.0474$ ). However, other parameters, including iron, zinc, selenium levels, and blood pressure, showed no differences based on medication adherence ( $p>0.05$ ).

**Table 2.** Micronutrients, Cortisol and Blood Pressure of Pregnant Women based on Age

| Parameters                     | 18-26 years      | 22-35 years      | 36-43 years      | p-value |
|--------------------------------|------------------|------------------|------------------|---------|
| Iron ( $\mu\text{g/dL}$ )      | 53.15 $\pm$ 14.7 | 47.03 $\pm$ 13.6 | 49.24 $\pm$ 16.8 | 0.261   |
| Zinc ( $\mu\text{g/dL}$ )      | 62.3 $\pm$ 11.6  | 59.3 $\pm$ 11.85 | 58.9 $\pm$ 8.08  | 0.379   |
| Selenium ( $\mu\text{g/L}$ )   | 79.7 $\pm$ 19.6  | 83.4 $\pm$ 19.16 | 80.2 $\pm$ 22.45 | 0.723   |
| Cortisol ( $\text{ng/mL}$ )    | 214.6 $\pm$ 49.1 | 210.4 $\pm$ 64.3 | 201.4 $\pm$ 46.6 | 0.591   |
| Systolic BP ( $\text{mmHg}$ )  | 112.09 $\pm$ 9.3 | 115 $\pm$ 12.28  | 117.4 $\pm$ 11.6 | 0.155   |
| Diastolic BP ( $\text{mmHg}$ ) | 76.16 $\pm$ 7.15 | 75.7 $\pm$ 8.29  | 74.9 $\pm$ 8.17  | 0.823   |

Data are presented as mean $\pm$ standard deviation. BP: blood pressure. Statistical comparisons among the age groups (18–26, 27–35, and 36–43 years) were performed using one-way ANOVA. No significant differences were observed among the groups for any of the parameters ( $p>0.05$ ).

**Table 3.** Micronutrients, cortisol level and blood pressure of pregnant women based on trimester

| Parameters                     | 1 <sup>st</sup> Trimester | 2 <sup>nd</sup> Trimester | 3 <sup>rd</sup> Trimester | P value |
|--------------------------------|---------------------------|---------------------------|---------------------------|---------|
| Iron ( $\mu\text{g/dL}$ )      | 51.6 $\pm$ 17.11          | 46.7 $\pm$ 14.27          | 50.7 $\pm$ 13.97          | 0.354   |
| Zinc ( $\mu\text{g/dL}$ )      | 61.8 $\pm$ 9.89           | 59.9 $\pm$ 10.8           | 58.4 $\pm$ 11.14          | 0.423   |
| Selenium ( $\mu\text{g/L}$ )   | 76.2 $\pm$ 17.2           | 84.8 $\pm$ 20.48          | 82.5 $\pm$ 22.8           | 0.187   |
| Cortisol ( $\text{ng/mL}$ )    | 201.1 $\pm$ 47.9          | 210.3 $\pm$ 62.5          | 214.6 $\pm$ 50.1          | 0.579   |
| Systolic BP ( $\text{mmHg}$ )  | 116.1 $\pm$ 13.8          | 114.8 $\pm$ 9.53          | 114.03 $\pm$ 10.2         | 0.756   |
| Diastolic BP ( $\text{mmHg}$ ) | 75.9 $\pm$ 9.33           | 75.3 $\pm$ 7.24           | 75.48 $\pm$ 6.9           | 0.949   |

Data are presented as mean $\pm$ standard deviation. BP: blood pressure. Statistical comparisons among trimesters were performed using one-way ANOVA. No differences were observed in iron, zinc, selenium, cortisol, or blood pressure measurements across the first, second, and third trimesters ( $p>0.05$ ).

**Table 4.** Micronutrients, Cortisol and Blood Pressure of Pregnant based on Adherence to Routine Medications

| Parameters                     | Always            | Not Always        | P value |
|--------------------------------|-------------------|-------------------|---------|
| Iron ( $\mu\text{g/dL}$ )      | 49.76 $\pm$ 15.78 | 49.4 $\pm$ 13.99  | 0.925   |
| Zinc ( $\mu\text{g/dL}$ )      | 59.85 $\pm$ 11.01 | 60.81 $\pm$ 9.6   | 0.681   |
| Selenium ( $\mu\text{g/L}$ )   | 82.03 $\pm$ 21.73 | 79.1 $\pm$ 16.68  | 0.516   |
| Cortisol ( $\text{ng/mL}$ )    | 215.2 $\pm$ 48.51 | 191.8 $\pm$ 63.17 | 0.047   |
| Systolic BP ( $\text{mmHg}$ )  | 114.52 $\pm$ 11.9 | 116.2 $\pm$ 9.85  | 0.496   |
| Diastolic BP ( $\text{mmHg}$ ) | 76.23 $\pm$ 8.2   | 73.97 $\pm$ 6.75  | 0.191   |

Data are presented as mean  $\pm$  standard deviation. BP: blood pressure. Statistical comparisons were performed using independent sample *t*-tests. No differences were observed between pregnant who always adhered to routine medications and those who did not, except for cortisol levels, which were significantly higher in the adherence group ( $p=0.047$ ).

## Discussion

The study examined the levels of selenium, zinc, iron, cortisol and blood pressure in pregnant women attending a healthcare facility in Anambra State. From the findings, selenium, zinc, and iron levels were lower in pregnant women compared to non-pregnant women, emphasizing the role of dietary intake and supplementation in mitigating deficiencies.

Selenium and zinc are critical for antioxidant defense and immune function, which are vital during pregnancy. The observed lower levels may be attributed to the physiological demands of these micronutrients during pregnancy, characterized by increased requirements for micronutrients to support fetal development, maternal tissue growth, and placental function. Alongside selenium, sufficient zinc intake plays a critical role in supporting successful embryogenesis and lowering the likelihood of preterm birth (10). These results align with those of Iqbal *et al.* (3) and Ilechukwu *et al.* (6), who also reported lower selenium and zinc in pregnant women. Joseph *et al.*, similarly, observed lower zinc levels but higher selenium levels in women at the late stage of pregnancy (11), while Karita *et al.* did not observe any differences in the plasma selenium levels of pregnant and non-pregnant Japanese women (12).

During pregnancy, the increased iron requires often exceed what can be obtained from dietary alone, making expectant mothers more susceptible to iron deficiency anaemia. Iron deficiency is common due to expanded blood volume and increased iron utilization for erythropoiesis and fetal needs. This explains the lower iron levels observed in pregnant women in the present study, which corroborates the study done by Aloy-Amadi *et al.* on pregnant women in Nnewi, Anambra State (13). Lower levels of hemoglobin, an iron-rich protein found in red blood cells have also been reported in pregnant women (14). However, Ezeugwunne *et al.* in their study did not observe any differences in the mean hemoglobin of pregnant women compared to the non-pregnant in Nnewi, Anambra State (15). The differences in the reported results may be due to nutritional status, environmental factors or population characteristics. Findings underscore importance of adequate micronutrient intake during pregnancy to prevent complications such as oxidative stress, anemia, and impaired fetal growth.

The higher cortisol levels in pregnant women can be attributed to the physiological stress of pregnancy and the activation of the HPA axis. Cortisol plays a vital role in fetal development, particularly in lung maturation and, regulation of metabolism. However, excessive cortisol may have adverse effects, including increased risk of gestational diabetes and hypertension. The finding is consistent with that of Vrijkotte et al., who also observed higher cortisol levels in pregnant women from 5 to 20 weeks of gestation (16).

The lower systolic and diastolic blood pressure observed in pregnant women compared to non-pregnant women may reflect the hemodynamic changes during pregnancy. Zhang et al. observed a decrease in blood pressure during early pregnancy, followed by a gradual increase in the mid and late stages of pregnancy (17). The decrease is usually associated with vasodilation and decreased peripheral vascular resistance (18). These changes are considered adaptive mechanisms to meet the circulatory demands of pregnancy. However, deviations from the normal pattern can have significant implications for maternal and fetal health. Ezeugwunne et al., however, observed higher systolic and diastolic pressures in pregnant women compared to the control group (15).

There was a remarkable consistency in micronutrients, cortisol, and blood pressure levels among pregnant women across different maternal ages, trimesters, and medication adherence categories, with a notable exception in cortisol level, which was significantly higher in pregnant women who took their routine drugs regularly. This consistency can be attributed to body homeostatic mechanisms, which regulate these parameters to meet the physiological demands of pregnancy. Regardless of age, the gradual physiological changes throughout pregnancy likely allowed for balanced adaptations, minimizing variations across trimesters. For women who occasionally

skipped medications, compensatory nutrient-rich diets or baseline nutrient sufficiency could have mitigated any significant deficits. Similarly, the observed stability in pressure may reflect the effectiveness of cardiovascular adaptations during pregnancy, which maintain equilibrium despite differences in these variables. On the contrary, Ezeugwunne *et al.* found higher systolic and diastolic blood pressure values in 6-9 months compared to 3-5 months (15). Aloy-Amadi *et al.* reported that serum iron decreased with increased gestational age and decreased progressively in each trimester (13).

The difference in cortisol based on medication adherence highlights the importance of consistent prenatal care. Pregnant women who adhered to their medication regimen exhibited higher cortisol levels, which may reflect better physiological adaptation to pregnancy. Non-adherence could contribute to suboptimal health outcomes, including stress-related complications. The higher cortisol in pregnant women who consistently take their routine medications compared to those who do not could reflect better physiological adaptation to pregnancy. Regular medication adherence, including prenatal supplements, may optimize nutritional status and support the HPA axis, enhancing cortisol production essential for fetal development. Moreover, consistent medication use might synchronize hormonal responses, contributing to elevated cortisol as part of the body's natural stress regulatory mechanisms. Therefore, healthy and moderate levels of glucocorticoids were related to an adequate development of cognitive and emotional brain networks during certain sensitive periods (19), since these levels are not considered harmful for the infant.

## Conclusion

The findings of the present study underscore the need for targeted interventions to address micronutrient deficiency and optimize maternal health. The prenatal supplementation, dietary

counseling, and regular monitoring of micro-nutrients should be integral components of antenatal care. Future research should explore long-term effects of micronutrient deficiencies on maternal and child health, as well as the efficacy of the supplementation programs in diverse populations.

### Conflict of Interest

The authors reported no conflicts of interest.

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