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RESEARCH ARTICLE

Assessment of some trace elements in pregnancy

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ABSTRACT

Concentrations of various trace elements are altered during pregnancy with changes in the mother's physiology and the requirements of growing fetus. The aim of the present study was to evaluate the level of some trace elements: Iron (Fe), Zinc (Zn), Selenium (Se), and Chromium (Cr) of pregnant women in Ekpoma, Edo State. A total of 160 subjects were studied. One hundred and twenty were pregnant women in the three trimesters of pregnancy and 40 were control. Atomic absorption spectrophotometer was used to determine the zinc, iron, selenium, and chromium levels of the trace elements in the serum. The mean age (years) of the subjects in the three trimesters was 30.12 ± 5.60, 28.23 ± 5.47, and 29.04 ± 4.04, respectively. The mean gestational age (weeks) of the three trimesters was 9.94 ± 1.75, 21.27 ± 3.83, and 34.42 ± 2.90, respectively. The mean weight (Kg) in the different trimesters was 69.71 ± 14, 1 71.14 ± 14.77, and 81.46 ± 10.35, respectively. The mean ± standard deviation of zinc in the first, second, and third trimesters of pregnancy was 79.50 ± 15.00 ug/dl, 74.50 ± 16.10 ug/dl, and 65.30 ± 14.90 ug/dl, iron was 76.00 ± 17.80 ug/dl, 63.5 ± 15.20 ug/dl, and 60.1 ± 14.40 ug/dl, selenium was 24.57 ± 2.77 ug/dl, 21.57 ± 2.77 ug/dl, and 16.60 ± 9.52 ug/dl, and chromium was 0.80 ± 0.10 ug/dl, 0.93 ± 0.87 ug/dl, and 0.56 ± 38 ug/dl, respectively. In conclusion, there was significant difference ($P < 0.05$) in iron, zinc, and selenium levels among the three trimesters of pregnancy and also compared with the control (122.19 ± 20.36 ug/dl, 98.34 ± 10.21 ug/dl, and 38.85 ± 4.81 ug/dl) while there was a non-significant decrease ($P > 0.05$) in chromium from first to third trimester of pregnancy compared with control. The practice to routine nutritional supplement such as iron, zinc, and folic acid with the aim of preventing nutritional deficiencies in pregnancy is thus recommended.

Keywords: Pregnancy, Trace, Element, Trimester

INTRODUCTION

Pregnancy, also known as gravidity or gestation, is the period during which a woman's body develops one or more babies.[1] A typical pregnancy is separated into three trimesters. The first trimester lasts from week 1 to week 12, and it is during this time that the baby is conceived.[1] The second trimester lasts from week 13 to week 28, and the third trimester lasts from week 29 to week 40.[2] Improved diet, extra folic acid,[3] avoiding drugs and alcohol, regular exercise, blood testing, and regular physical examinations are all examples of prenatal care that improve pregnancy outcomes.[4] Selenium is important for metabolism.[5] Selenium salts are hazardous in large doses, but minute amounts are required for cellular activity in many

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creatures, including all animals, and it is found in a variety of multivitamins and other nutritional supplements, including infant formula.[6] Selenium is well-known in mammals for its metabolic role and as a component of the enzyme glutathione peroxidase, which, along with Vitamin E, catalase, and superoxide dismutase, forms part of one of the body's antioxidant defense systems.[7]

Iron is a component of enzymes that is required for immune cell activity and is involved in the regulation of cytokine production and action.[8] It is also a key component in the transmission of oxygen throughout the body. Iron absorption and loss are meticulously managed. When iron is chelated to amino acids, it is most readily available to the body, and it is also available as a popular iron supplement. Anemia is caused by an iron deficiency, which might increase the risk of death after delivery due to a hemorrhage.[9] Low iron levels are particularly dangerous for blood donors and pregnant women, who are frequently advised to boost their iron consumption.[10]

Zinc is the second most common trace element on the planet. Zinc is involved in carbohydrate, lipid, protein, and nucleic acid synthesis and breakdown.[11] It serves as a cofactor for over 100 zinc-dependent enzymes in the body, including DNA polymerase, alkaline phosphatase, carboxypeptidase, and others.[10] Normal growth, immune system, cell growth, collagen synthesis, wound healing, bone metabolism, reproduction, taste, smell, and vision are all regulated by these enzymes.[11] Zinc deficiency has been linked to pregnancy and delivery problems, as well as fetal growth retardation and congenital defects.[12]

Although the mechanisms of action in the body and the amounts required for good health are not well characterized, chromium is a mineral that humans require in trace amounts.[13] There are two types of chromium: (1) Trivalent (chromium 3+), which is biologically active and found in food and (2) hexavalent (chromium 6+), which is harmful and originates from industrial contamination.[14] Chromium has been shown to improve the function of insulin, a hormone that regulates glucose, lipid, and protein metabolism and storage in the body.[15] Chromium is an essential vitamin that regulates glucose, lipid, and protein metabolism by potentiating insulin activity.

Both the mother and the fetus experience fast growth and cell differentiation throughout pregnancy. As a result, it is a time when women are particularly vulnerable to changes in food supply, particularly of micronutrients that are scarce in certain circumstances.[2] Infertility, pregnancy, congenital abruption, preterm rupture of membranes, stillbirths, and low birth weight have all been linked to trace element deficiencies such as zinc, selenium, iron, and chromium.[8] According to the certain studies, the concentrations of various trace elements change throughout pregnancy.[6,9] However, none of such study has been carried out in our study area. Hence, this research was carried out to determine the serum levels of iron, selenium, zinc, and chromium in the different trimesters of pregnancy among pregnant women in Ekpoma, Edo State.

MATERIALS AND METHODS

This study was carried out in Ekpoma, the administrative headquarters of Esan West Local Government Area of Edo State, Nigeria. The area lies between latitudes 6^0 43' and 6^0 45' North of the equator and longitudes 6° 5' and 6° 8' East of the Greenwich median. Ekpoma has a land area of 923 square kilometers with a population of 170, 123 people as at the 2006 census. Selection of these subjects was based on the following criteria: Pregnant women with normal BP, absence of proteinuria, and without any other systemic or endemic disorder. All subjects with obesity, severe anemia, or suffering from any hepatic dysfunction or dyslipidemia were excluded from the study.

Sample size and sample collection

A total of 160 samples were used in this study, comprising of 120 pregnant women divided into three groups of 40 women each, that is, first trimester, second trimester, and third trimester, respectively, and 40 apparently healthy non-pregnant women as control. Five ml of blood sample was collected from fasting subjects through venipuncture into a plain container without any additive to determine the serum trace metals (zinc, iron, selenium, and chromium). It was allowed to stand for 1 h to clot. It was then centrifuged at 3000g for 10 min and the serum was isolated and stored at –4°C until required for analysis.

Sample analysis

Zinc, chromium, iron, and selenium concentrations in serum were estimated by atomic absorption spectrophotometer (AAS). The AAS using the Beck 20 machine. Working standard solution was prepared by diluting the stock standard with deionized water and the required PPM used for the standardization of the corresponding trace metals. A portion of the thawed samples was taken after ensuring thorough mixing, added to a clean 10 ml centrifuge tube, and diluted to 10 ml with 0.1 M hydrochloric acid. The diluted serum sample was then centrifuged (3000 rev/min) to remove cellular debris and aspirated directly into the flame for analysis and data recording. All analysis was carried out in the Clinical Chemistry Laboratory at University College Hospital, Ibadan, Oyo State, Nigeria.

Principle of the test

Serum trace metals were determined with flame AAS using direct method as described by Kaneko (1991). The atoms of the elements, when aspirated into the AAS, vaporized, and absorb light of the same wavelength as that emitted by the metal when in the excited state, that is, in the vaporized ground state (unexcited) atom of a trace metal in the excited state. The amount of light absorbed is proportional to the trace metal in the solution.

Statistical analysis

The results were presented in tables. Data were presented as mean ± standard deviation (SD). Comparison was made between test subjects and control groups using one-way analysis of variance and the student's t-test. Significant difference was accepted at $P < 0.05$.

RESULTS

Table 1 showed the demographic characteristics of the subjects in the different trimesters of pregnancy. The mean age in years of pregnant women in the first, second, and third trimesters was 30.12 ± 5.60, 28.23 ± 5.47, and 29.04 ± 4.04, respectively, while that of the control was 28.20 ± 6.30 and the age range was 18–40 years. The mean gestational age of the subjects in weeks at the different trimesters was 9.94 ± 1.75, 21.27 ± 3.83, and 34.42 ± 2.90, respectively. The mean weights (kg) in the different trimesters were 69.71 ± 14.05, 1 71.14 ± 14.77, and 81.46 ± 10.35, respectively, while the mean weight (kg) of the control group was 64.60 ± 10.62. Table 2 showed the mean distribution of serum zinc, iron, selenium, and chromium of the subjects in the different trimesters of pregnancy. The mean ± SD of zinc in the first, second, and third trimesters of pregnancy was 79.50 ± 15.00 ug/dl, 74.50 ± 16.10 ug/dl, and 65.30 ± 14.90 ug/dl, iron was 76.00 ± 17.80 ug/dl, 63.5 ± 15.20 ug/dl, and 60.1 ± 14.40 ug/dl, selenium was 24.57 ± 2.77 ug/dl, 21.57 ± 2.77 ug/dl, and 16.60 ± 9.52 ug/dl, and chromium was 0.80 ± 0.10 ug/dl, 0.93 ± 0.87 ug/dl, and 0.56 ± 38 ug/dl, respectively. There was a significant difference ($P < 0.05$) in iron, zinc, and selenium levels in the three trimesters of pregnancy as the values decrease from first to the third trimester. In comparison with the values in the first trimester of serum chromium, there was a non-significant decrease ($P > 0.05$) in the third trimester.

DISCUSSION

Pregnancy is a natural occurrence that causes a wide range of internal physical physiological changes in women.[16] This study was carried out to determine the serum levels of iron, selenium, zinc, and chromium in the different trimesters of pregnancy among pregnant women in Ekpoma, Edo State.

Our results showed that there was a significant ($P < 0.05$) decrease in the serum iron of pregnant women in the first (76.00 µg/dl), second (63.50 µg/dl), and third trimester (60.1 µg/dl) compared with the control (122.19 µg/dl) [Table 2]. This reflects the fact that the iron stores in a pregnant woman's

Table 1: Some demographic characteristics of the subjects in the different trimesters of pregnancy

Variables	First trimester (*n*=40)	Second trimester (*n*=40)	Third trimester (*n*=40)	Control (*n*=40)
Age (years)	30.12±5.60	28.23±5.47	29.04±4.04	28.20±6.30
Gestational age (weeks)	9.94±1.75	21.27±3.83	34.42±2.90	-
Weight (Kg)	69.71 ± 14.05	81.46 ± 10.35	1 71.14 ± 14.77	64.60 ± 10.62

Kg: Kilogram

Table 2: Mean distribution of serum zinc, iron, selenium, and chromium of the subjects in the different trimesters of pregnancy

	Trimesters				*P*-value
	First trimester Mean±SD (*n*=40)	Second trimester Mean±SD (*n*=40)	Third trimester Mean±SD (*n*=40)	Control Mean±SD (*n*=40)	
Zinc (ug/dl)	79.50±15.0	74.50±16.10	65.30±14.90	98.34±10.21	0.000
Iron (mg/dl)	76.0±17.80	63.50±15.20	60.10±14.40	122.19±20.36	0.000
Selenium (mg/dl)	24.57±2.77	21.57±2.77	16.60±9.52	38.85±4.81	0.001
Chromium (mg/dl)	0.80 ± 0.10	0.93 ± 0.87	0.56 ± 38	1.14 ± 0.19	0.366

$P>0.05$=Not significant difference; *$P<0.05$=Significant difference

body decrease over time. A research in Africa and Nigeria[1] also found similar variations in serum iron levels throughout pregnancy. Furthermore, the findings of this study corroborate recent research from the United Kingdom,[17] China,[18] and India,[19] all of which found a significant reduction in iron levels in pregnant women.

Iron deficiency can impact immunity, growth, and development, as well as reduce oxygen carrying capacity due to lowered hemoglobin levels. Iron requirements for the baby, placenta, and maternal red cell growth are typically very high during pregnancy.[20] Anemia caused by low iron levels in the blood has been linked to poor pregnancy outcomes all around the world. The iron shortage among pregnant women discovered in this study could possibly be attributed to insufficient iron intake.[21]

The mean zinc concentration of pregnant women in the first, second, and third trimesters was 79.50 µg/dl, 74.5 µg/dl, and 65.3 µg/dl, respectively. Zinc level of the subjects significantly ($P < 0.05$) decreased during pregnancy from first trimester to third trimester compared with the control (98.34 µg/dl). This finding is consistent with a previous study in the Eastern part of Nigeria by Eke *et al*.[22] that found a lower cutoff of serum zinc levels (60 g/dL) among pregnant women in the third trimester compared to non-pregnant women, and another study in India that found a cutoff of only 50 g/dL among pregnant women in the third trimester compared to non-pregnant women.[23]

Reyes *et al.*[24] found that pregnant women had a lower serum zinc level (47 g/dL) than non-pregnant women (83 g/dL) in a study conducted in Bangladesh. Other investigations in Turkey[25] and China[26] showed similar results.

A disproportionate increase in plasma volume, as well as maternal–fetal transfer, could explain the decrease in serum zinc in pregnant women. Other possible causes include decreased zinc binding,[27] insufficient zinc intake or low dietary bioavailability,[28] or very high levels of copper or iron in the diet that compete with zinc for absorption sites.[29] Low serum zinc levels during pregnancy could also be caused by poor pre-pregnancy nutritional status and low serum zinc levels.[30] Although serum zinc levels cannot be used to determine whether or not a person is deficient in zinc, this biochemical indication has been shown to be the greatest available indicator of the risk of zinc deficiency since it reflects dietary zinc intake.[31]

From the results of this study, selenium levels were significantly ($P < 0.05$) lower in pregnant women especially in the second (21.57 µg/dl) and third trimesters of pregnancy (16.60 µg/dl) than in healthy non-pregnant women (38.85 µg/dl) as shown in Table 2. This finding is in consonant with the previous study by Butler *et al.*[32] who found significantly ($P < 0.001$) lower levels of selenium among pregnant women compared with non-pregnant women. However, no variations in serum selenium levels were found between healthy pregnant and non-pregnant women in investigations conducted in Spain[33] and Japan,[34] respectively. Preeclampsia,[35] intrahepatic cholestasis, gestational and pre-gestational diabetes, and recurrent pregnancy loss have all been linked to low selenium levels.[36] Furthermore, a low plasma selenium level is linked to an increased risk of fetal death, child death, and intrapartum HIV transmission from mother to child.[37]

The reduced levels of selenium in pregnant women found in this study could be due to a variety of factors. It has been found that active selenium transfer from maternal blood to the tissues of the developing fetus reduces maternal blood selenium. Furthermore, whereas city inhabitants may enjoy a diverse and abundant diet, the opposite is true for rural dwellers, who may lose trace elements due to poor farming practices, strong tropical rains, and erosion. Furthermore, tubers (particularly cassava) are commonly consumed in rural regions and are not known to contain large quantities of selenium.[23]

In this study, there was no significant difference ($P > 0.05$) in the serum values of chromium in the different trimesters of pregnancy although there was a decrease in the concentration of chromium in the third trimester (0.56 µg/dl) compared with the first trimester (0.80 µg/dl), second trimester (0.93 µg/dl), and control group (1.14 µg/dl), respectively. This finding is consistent with prior research by Steams,[14] Vincent,[15] and Sheldon *et al.*,[29] who found no significant difference ($P > 0.05$) in chromium levels in the blood during the several trimesters of pregnancy. Chromium is carried in the plasma by its association with transferrin. This shows that plasma chromium levels are influenced by the availability of iron. This could explain why the serum chromium level of pregnant women investigated decreased in the third trimester as compared to the first trimester and control participants, respectively.

CONCLUSION

There was a significant difference ($P < 0.05$) in iron, zinc, and selenium levels in the three trimesters of pregnancy compared with control, while there was a non-significant decrease ($P > 0.05$) in chromium from first to third trimester of pregnancy compared with control. This discovery will aid in determining the health state of pregnant women in the research area to provide proper medical care. It is thus recommended to take nutritional supplements such as iron, zinc, and folic acid on a regular basis to avoid nutritional deficiency during pregnancy.

REFERENCES

1. James PM. Nutrition and human development in Nigeria: A case study of pregnant women. Nutr Rev 2005;16:1-11.
2. Wylie L. Essential Anatomy and Physiology in Maternity Care. Edinburgh: Churchill Livingstone; 2005. p. 172-9.
3. Centers for Disease Control and Prevention. Use of supplements containing folic acid among women of childbearing age-United States, 2007. MMWR Morb Mortal Wkly Rep 2008;57:5-8.
4. Ramakrishnan U, Manjrekar R, Rivera J, Gonzalescossio T, Martorell R. Micronutrients and pregnancy outcome. A review of the literature. Nutr Res 1999;19:103-12.
5. Burk RF, Levander OA. Selenium. In: Modern Nutrition in Health and Disease. Philadelphia, PA: Lippincott Williams and Wilkins; 2009. p. 265-76.
6. Nwagha UI, Ogbodo SO, Nwogu-Ikojo EE, Ibegbu DM, Ejezie FE, Dim CC. Copper and Selenium status of healthy pregnant women in Enugu South Easter Nigeria. Nigeria J Clin Pract 2011;14:408-12.
7. Hiten CD, Christopher WG, Fiona BP, Lucilla P. Selenium in reproductive health. Am J Obstetr Gynaecol 2011;206:21-30.
8. Allen LH. Anaemia and iron deficiency: Effects on pregnancy outcomes. Am J Clin Nutr 2000;71:1280-4.
9. Black RE. Micronutrients in pregnancy. Br J Nutr 2001;85:193-203.
10. Sukhsate B. Importance of trace elements in the human body. Healthy Eating 2015;49:2-4.
11. King JC, Keen CL. Zinc. In: Modern Nutrition in Health and Disease. Philadelphia, PA: Lippincott Williams and Wilkins; 1999. p. 223-39.
12. Kosuke K, Donna S, Anuraj H, Shankar W, Fawzi A. Maternal multiple micronutrient supplementation and pregnancy outcomes in developing countries: Metaanalysis and meta-regression. Bull World Health Organ 2011;8:402-11.
13. Mills CF. Biological roles of trace elements. In: Nutrition in Health and Disease. New York: Alan R. Liss; 2005. p. 179-88.
14. Steams DM. Is chromium a trace essential metal? Biofactors 2000;11:149-62.
15. Vincent JB. The biochemistry of chromium. J Nutr 2000;130:715-8.
16. Al-Shoshan AA. Diet history and birth weight relationship among Saudi pregnant women. Pak J Med

Sci 2007;7:176-81.
17. Simpson KM, Morris ER, Cook JD. The inhibitory effect of bran on iron absorption in man. Am J Clin Nutr 2001;3:14-8.
18. Liao QK. Prevalence of iron deficiency in pregnant and premenopausal women in China: A nationwide epidemiological survey. Br J Nutr 2004;85:193-6.
19. Pathak P, Kapil U, Kapoor SK, Saxena R, Kumar A, Gupta N. Prevalence of multiple micronutrient deficiencies amongst pregnant women in a rural area of Haryana. Indian J Pediatr 2004;71:1007-14.
20. Fairbanks VF. Role of Iron in human health. In: Iron in medicine and nutrition. Philadelphia, PA: Lippincott Williams and Wilkins; 1999. p. 193-221.
21. O'Dell BL, Sunde RA. Handbook of Nutritionally Essential Mineral Elements. New York: Marcel Dekker, Inc.; 1997. p. 34-9.
22. Eke U, Azuka P, Ifeanyi S, Uchenna E. Zinc and magnesium nutriture amongst pregnant mothers in Eastern communities in Nigeria. Niger Pediatr 2002;3:365-8.
23. Olife IC, Okaka AN, Dioka CE, Meludu SC, Orisakwe OE. Iron status and the effect of soil erosion on trace elements in Nanka and Oba towns of Anambra State, Nigeria. Ann Chem 2007;9:895-903.
24. Reyes H, Sandoval L, Wainstein A, Francisca E, Doodley WL. Acute fatty liver of pregnancy: A clinical study of 12 episodes in 11 patients. Gut 1994;35:101-6.
25. Ilhan N, Simsek M. The changes of trace elements, malondialdehyde levels and superoxide dismutase activities in pregnancy with or without preeclampsia. Clin Biochem 2002;35:393-7.
26. Liu J, Yang H, Shi H, Shen C, Zhou W, Dai Q. Blood copper, zinc, calcium, and magnesium levels during different duration of pregnancy in Chinese. Biol Trace Element Res 2010;3:31-7.
27. Tamura T, Goldenberg RL, Johnston KE, DuBard M. Maternal plasma zinc concentrations and pregnancy outcome. Am J Clin Nutr 2000;71:109-13.
28. Tuttle S. Trace element requirements during pregnancy. In: Nutrition in Pregnancy. London: Royal College of Gynaecologists; 2003. p. 19-34.
29. Sheldon WL, Aspillaga MO, Smith PA, Lind T. The effects of oral iron supplementation on zinc and magnesium levels during pregnancy. Br J Obstetr Gynaecol 2005;92:892-8.
30. Gibson R. Zinc nutrition in developing countries. Nutr Res Rev 2004;7:151-73.
31. Iqbal AS, Shahidullah M, Nurul I, Sohela A, Shahanara B. Serum zinc and copper levels in the maternal blood and cord blood of neonates. Indian J Paediatr 2001;6:523-6.
32. Butler JA, Whanger PD, Tripp MJ. Blood selenium and glutathione peroxidsase activity in pregnant women: Comparative assays in primates and other animals. Am J Clin Nutr 2002;36:15-23.
33. Navarro M, López H, Pérez V, Zumpa MC. Serum selenium levels during normal pregnancy in healthy Spanish women. Sci Total Environ 1996;18:237-42.
34. Karita K, Takano T, Satoh K, Suzuki T. Variations in plasma selenium levels as a result of the menstrual cycle and pregnancy in healthy Japanese women. Biol Trace Element Res 2004;9:83-91.
35. Rayman MP, Bode P, Redman CW. Low selenium status is associated with the occurrence of the pregnancy disease pre-eclampsia in women from the United Kingdom. Am J Obstetr Gynaecol 2003;18:3-9.
36. Mistry HD, Wilson V, Ramsy MM, Symonds ME, Pipkin FB. Reduced selenium concentrations and glutathione peroxidase activity in preeclamptic pregnancies. Hypertension 2008;5:81-8.
37. Kupka R, Garland M, Msamanga G, Spiegelman D, Hunter D, Fawzi W. Selenium status, pregnancy outcomes, and mother-to-child transmission of HIV-1. J Acq Immune Def Syndrome 2005;3:20-30.