Original Research Article

Serum Levels of Some Nutritional, Hepatic and Renal Markers in Third Trimester Pregnant Women

ABSTRACT

Purpose: Nutritional status, before and during pregnancy, is a strong determinant of health outcomes in the mother and newborn, and can affect the foetal structure, physiology and metabolism. Maternal health, hepato-renal function, as well as calcium and magnesium levels during pregnancy are closely related, and have a great effect on the infant health outcome. The study was aimed at assessing serum levels of some nutritional parameters (total protein, albumin, calcium and magnesium), hepatic (alanine aminotransferase, aspartate aminotransferase, bilirubin, alkaline phosphatase) and renal (urea, creatinine) biomarkers and relate them with neonatal birth weight. **Methods/Participants:** Forty pregnant women in the third trimester (29 weeks to term) attending antenatal clinics for the first time, at two maternity centres within Osogbo metropolis were recruited as test participants. Forty age-matched, non-pregnant women served as control. Serum obtained from 5 mL of blood was used for the analyses. Inductive Computerized Plasma Emission Spectrometry was used for elemental study. Standard photometric methods were used to assay hepatic and renal parameters. Some pregnancy outcomes were also determined. Data were analyzed using Student's t test and Pearson's correlation coefficient. $P \leq 0.05$ was considered significant. **Results**: It was revealed that at third trimester some nutritional parameters (total protein, albumin, iron, calcium) were significantly decreased while renal biomarkers and alkaline phosphatase showed significant increase compared with control. Low birth weight but no still birth was observed. **Conclusion:** The significant decrease in levels of albumin and some nutritional parameters suggests inadequate nutrient intake of protein and minerals or confirms increased demand commonly linked with pregnancy; and may be a possible cause of low birth weight.

Keywords: Gestation; third trimester; hepato-renal markers; nutritional indices; birth outcome

INTRODUCTION

Nutrition is the branch of science that shows the relationship of food to the functioning of living organisms. It includes the uptake of food, liberation of energy, elimination of wastes and the biochemical synthesis that are essential for maintenance of normal growth and development [1].The nutritional status of any person is dictated by the quality of nutrients consumed, and the body's ability to utilize them for its metabolic needs.

Nutritional status, before and during pregnancy, is a strong determinant of health outcomes in the mother and newborn, and can affect the foetal structure, physiology and metabolism [2]. Both maternal health, role of liver, kidney, and essential elements during pregnancy, which are closely related, have a great effect on the infant health outcome [2, 3]. Oh *et al.* [4] noted that anaemia in pregnancy is common and is thought to contribute significantly to maternal mortality and morbidity in developing countries. Maine [5] however, showed there is little evidence that nutrition plays a role in pregnancy outcomes. There is a need to better understand the role of this interrelatedness during and after pregnancy and the potential pathways linking them to the newborn and infants health.

Pregnancy is the period of dynamic change for a mother requiring a lot of care. During this period the foetus is nourished directly by the mother through placenta. Since the baby totally relies upon its mother for nourishment, the pregnant woman is to be provided with an adequate and well-balanced diet [6] which can be assessed by 24- hour food recall, food frequency questionnaire, biochemical parameters, etc. Maternal nutrition and health are considered as the most important regulator of human foetal growth. If women are not well nourished, they are more likely to give birth to weak babies resulting in high infant mortality rate as well as high rate of maternal mortality [7].

A woman's normal nutritional requirement increases during pregnancy in order to meet the needs of the growing foetus and of maternal tissues associated with pregnancy. Proper dietary balance is necessary to ensure sufficient energy intake for adequate growth of foetus without drawing on mother's own tissues to maintain her pregnancy [8].

The role of adequate nutritional status and good dietary intake during preconception and pregnancy has been identified as major contributors to healthy birth outcomes. Whereas, under-nutrition and suboptimal diets with poor energy and micronutrients during pregnancy have been linked with improper foetal growth, pre-term delivery, still birth and increased risk of chronic diseases in later life. Suboptimal prenatal diets have also been associated with gestational diabetes and pre-eclampsia in the mother and increased risk of still birth and large for-gestational age in the baby [9]. The previous prevalence of low birth was estimated to be 15.5% worldwide which translates to more than 20 million infants worldwide [10]. Unfortunately >90% of these low-birth-weight babies are born in the developing countries. The study was therefore designed to study the level of some serum levels of nutritional (total protein, albumin), hepatic (alanine aminotransferase, aspartate aminotransferase, bilirubin, alkaline phosphatase, gammaglutamyl transferase), renal (urea and creatinine) markers and relate them with neonatal birth weight.

MATERIALS AND METHODS

Ethical Consideration

The ethical clearance for the study was obtained from Health Research Ethics Committee of Hospital Management Board Asubiaro, Osogbo Osun state, Nigeria. Informed consents were obtained from the subjects who also willingly filled the questionnaires. The data obtained was kept in strict confidentiality.

Study participants (inclusion/ exclusion criteria)

The study participants included a total number of 80 women. 40 of the women were in the third trimester (29 weeks to term) of pregnancy, they were attending antenatal clinics at two maternity centers within Osogbo metropolis. The control subjects were 40 age-matched, non-pregnant and apparently healthy women, who were not menstruating at the time of sample collection. Other exclusion criteria included presence of hepatic and renal dysfunction as well as any other existing chronic diseases capable of altering estimated parameters. None of the participants was on nutrient supplementation.

Sampling technique/Study design/Data collection

Simple random sampling technique was employed in selection of participants. This is a cross sectional comparative study. Both groups willingly consented to be enrolled for the study as well as willingly filled the questionnaires.

Collection and Preparation of blood samples

Five millimeters (5 mL) of venous blood from the antecubital fosa was collected using pyrogen free needle and syringe with minimum stasis. This was carefully dispensed into dry, anti-coagulant free bottles. Each blood sample was allowed to clot, retracted and centrifuged at 2000 g for 10 minutes after which the serum was separated and stored at-20^{0}C prior to analyses. Inductive Computerized Plasma Emission Spectrometry was used to assay iron, calcium, chromium and magnesium while standard photometric methods (kits supplied by Randox) were used to assay hepatic and renal parameters- aspartate and alanine aminotransferases, alkaline phosphatase, bilirubin, urea and creatinine.

Statistical Analysis

Data were summarized as Mean ± Standard Error of Means (SEM) and analyzed using Statistical Package for Social Sciences (SPSS), version 15 (SPSS Inc., Chicago, IL, USA). Student's t test was the statistical method used for inferential statistical analysis. P≤ 0.05 was considered as significant.

RESULTS

The results of the study are presented below. In table 1 below, results of the estimated parameters are presented. At third trimester pregnancy, significant lower serum concentrations of total protein and albumin were observed when compared with those of non-pregnant control. But unlike albumin and total protein, globulin was significantly higher in pregnant participants compared with non-pregnant control. Renal markers, urea and creatinine were significantly higher in pregnant women compared with control. While the activity of alanine aminotransferase was not significantly different in pregnant women compared with control, activities of aspartate aminotransferase and alkaline phosphatase were significantly higher in pregnant women compared with non-pregnant subjects.

Iron, magnesium, and calcium were significantly lower in pregnant women compared with non-pregnant control. In addition, serum level of chromium was significant lower in pregnant women when compared with that of the control group. Neonatal birth weight was (2.36 ± 0.42 kg) and no still-birth was reported. .

DISCUSSION

Under-nutrition and suboptimal diets with poor energy and micronutrients (such as iron) have been associated with abnormal foetal growth, pre-term delivery, still-birth and increased risk of chronic diseases in later life. No still-birth was recorded in the course of this study, yet the low mean birth weight (2.36 ±0.42 kg) of babies born to test subjects indicates that these neonates may be at risk. It is important to emphasize that aside maternal nutrition; other factors that can affect birth weight of neonates include age, occupation, family income, pregnant experience and morning sickness [11]. The devastating impact of maternal malnutrition goes beyond the neonatal stage of life. Koletzko *et al.* [12] recognize that maternal nutrition during gestation is an essential factor not only for health of baby, but also for the baby's long term growth. While the unfavorable economic climate of many parts of the developing world could have resulted in significant low levels of serum iron as recorded in the present study, phytates found in all kinds of grains, seeds, nuts, vegetables, roots (e.g., potatoes), and fruits; strongly inhibit iron absorption in a dose-dependent fashion and even small amounts of phytates can have a marked effect. Since grains are much cheaper, it seems likely that the pregnant women consume more of phytate-containing food at the expense of others. This is a common observation in my parts of developing world.

A nutritional parameter is considered an ideal marker when it is both sensitive and specific to nutrition intake. Markers like albumin, transferrin, prealbumin, and retinol-binding protein (RBP) have been suggested as suitable indicators of nutrition status. But the use of albumin in assessment of nutritional status of patients has not only historic advantage but is still considered a highly sensitive maker for an individual patient's nutritional status in various current reports

[13]. Albumin best served this purpose when used in combination with other markers or parameters. Both albumin and nutritional parameters like iron, magnesium, and calcium were significantly decreased in third trimester pregnant women compared with controls.

Hepatic enzyme- alanine aminotransferase (ALT) that serves to establish that the integrity of hepatic parenchymal cells is not compromised was not significantly different, significant increase is an indication of hepatic damage. The ALT result ruled out hepatic damage as there was no significant difference between pregnant subjects and controls. The significant increase in the activity of aspartate aminotransferase (AST) could have been due to any other extra-hepatic reason, it is not specific to the liver whereas ALT is more specific to the liver. Meanwhile, Mutua *et al*. [14] reported that the effects of pregnancy in serum ALT and AST activity levels are somewhat controversial. In a few studies, a slight elevation in the activities of ALT and/or AST activity has been observed during the third trimester. However, results of many studies have shown that serum ALT and AST activity levels do not change during pregnancy or remain within the normal limits established in non-pregnant women. An increase in ALT or AST levels during labor has been linked with contractions of the uterine muscle during labour. According to several authors there seems to be no explanation for this slight increase in ALT/AST during the second trimester or early stages of third trimester in pregnant women compared to non-pregnant controls.

The significant increase in the activities of alkaline phosphatase can be linked to the placenta, although osteoblastic activities taking place in the developing foetal skeleton may be another source. McErlean and King [15] also observed that serum alkaline phosphatase (ALP) activity levels increase in late pregnancy, mainly during the third trimester, and that the increase in ALP activity during pregnancy is not as a result of increase in the hepatic isoenzyme but is rather largely due to the production of the placental isoenzyme. At the third trimester, there is enhanced production of the bone isoenzymes; an increase that may last as long as six weeks post-delivery [16, 17]. The significant decrease in levels of some nutritional parameters (total protein, albumin, iron, calcium) suggest inadequate nutrient intake, and may be a possible cause of low birth weight recorded in this study.

CONCLUSION

This study revealed that many of the nutritional parameters (Fe, Ca, Mg) required for various developmental stages in the intra-uteral life were deficient during third trimester of pregnancy in Osogbo based pregnant women. This may be responsible for the low birth weight. No abnormal hepatic dysfunction was detected, although renal markers were slight elevated. The significant higher levels of renal markers require further investigation.

REFERENCES

1. Maqbool M, Dar MA, Gani I, Mir SA, Khan M, Bhat AU. Maternal health and nutrition in pregnancy: an insight. World Journal of Pharmacy and Pharmaceutical Sciences. 2019; 8:450-459.
2. Huang Li-Tung. Maternal and early life nutrition and health. Inter. J. Environ Res and Public Health. 2020;17(21):7982. https://doi.org/10.3390/ijerph17217982
3. Mousa A, Naqash A, Lim S. Macronutrient and macronutrient intake during pregnancy: an overview of recent evidence. Nutrients. 2019;11(2): 443; https://doi.org/10.3390/nu11020443
4. Oh C, Keats EC, Bhutta ZA. Vitamin and mineral supplementation during pregnancy on maternal, birth, child health and development outcomes in low- and middle- income countries: a systemic review and meta-analysis. Nutrients. 2020;12(2):491. https://doi.org/10.3390/nu12020491
5. Maine D. Role of nutrition in the prevention of toxemia. Am J Clin Nutr. 2010; 72(suppl):298S–300S
6. Cetin I, Buhing K, Demir C, Kortam A, Prescott SL, Yamashiro Y, Yarmolinskaya M, Koletzko B. Impact of micronutrient status during pregnancy on early nutrition programming. Annals of Nutrition Metabolism. 2019; 74: 269-278. https://doi.org/10.1159/000499698
7. Manfredini M. The effects of nutrition on maternal mortality: evidence from 19th-20th century Italy. SSM Popul Health. 2020; 12: 100678. doi: 10.1016/j.ssmph.2020.100678
8. Most J, Dervis S, Haman F, Adamo KB, Redman LM. Energy intake requirements in pregnancy. Nutrients. 2019; 11(8): 1812 https://doi.org/10.3390/nu11081812
9. Billionet C, Mitanchez D, Weill A, Nizard J, Alla F, Hartemann A, Jacqueminet S. Gestational diabetes and adverse birth outcomes from 716,152 births in France in 2012. Diabetologia 2017; 60(4): 636-644. doi: 10.1007/s00125-017-4206-6
10. UNICEF/World Health Organization (2004) Low Birth Weight: Country, Regional and Global Estimate. New York and Geneva: UNICEF and WHO.
11. Hughes MM, Black RE, Katz J. 2500-G Low birth weight cutoffs: history and mplications for future research and policy. Matern Child Health J. 2017; 21(2): 283-289. Doi: 10. 1007/s10995-016-2131-9.
12. Koletzko B, Gofret KM, Poston L, Szajewska H, Goudoever JB, Waard M, Brands B, Grivell RM, Deussen AR, Dodd JM, Patro-Golab B, Zalewski BM. Early Nutrition Project Systemic review Group. 2019. Nutrition during pregnancy, lactation and early childhood and its implications for maternal and long-term child health: the early nutrition project recommendations. Ann Nutr Metab. 2019; 74(2): 93-106. DOI: 10.1159/000496471

13. Yuwen P, Chen W, Lv H, Feng C, Li Y, Zhang T, Hu P, Guo J, Tian Y, Liu L, Sun J, Zhang Y. Albumin and surgicalsite infection risk in orthopaedics: a meta-analysis. BMC Surg. 2017; 17(1):7.
14. Mutua DN, Nwaniki Njagi EN, Orinda G. Liver function tests in normal pregnant women. J. Liver 2018; 7: 228. doi: 10.4172/2167-0889.1000228
15. McErlean S, King C. Does an abnormally elevated maternal alkaline Phosphatase pose problems for the fetus? BMJ Case Reports 2019; 12(4):e229109 doi: 10.1136/bcr-2018-229109.
16. Prieto-Sanchez M, blanco-Carnero J, Ruiz-palacios M, Pagan A, Ruiz-Alcaraz AJ, Larque E. Increased alkaline Phosphatase in cord bblood of obese diabetic others is associated to polyunsaturated fatty acid levels. Ann Nutr metab 2019; 75(3):153-162. Doi: 10.1159/000504404.
17. Ferro B, Marques I, Paixao J, Almeida MC. Incidental finding of extreme elevation of serum alkaline phosphatase in pregnancy. Cureus 2021; 16(8): e17211. Doi: 10.7759/cureus.17211.

Table 1: The serum concentrations of estimated biochemical parameters of third trimester pregnant women and non-pregnant control

ESTIMATED PARAMETERS	CONTROL	PREGNANT WOMEN
Total protein (g/L)	75.98±1.15	62.10±0.73*
Globulin (g/L)	24.98±1.30	31.53±1.18*
Albumin (g/L)	44.45±1.05	36.95±1.16*
Urea (mmol/L)	4.52±0.08	5.00±0.06*
Creatinine (mmol/L)	0.73±0.03	0.88±0.02*
Alanine aminotransferase (IU/L)	16.35±4.11	18.25±4.73
Aspartate aminotransferase (IU/L)	21.38±5.70	27.63±4.80*
Alkaline Phosphatase (IU/L)	45.40±18.02	64.05±18.90*
Iron (µg/dL)	118.02±14.50*	57.61 ± 3.59
Calcium (mg/L)	7.03 ± 0.19	5.03 ± 0.17*
Magnesium (mg/L)	8.75±1.10	4.15±0.47*
Chromium (mg/L)	8.04±2.27	3.83 ±2.16*

*p significant at 0.05