Original Research Article

EVALUATION OF ZINC STATUS AND SOCIO-ECONOMIC PROFILE OF PREGNANT WOMEN IN OSOGBO METROPOLIS, SOUTH-WESTERN NIGERIA

Short title: zinc status and socio-demography of pregnant women

ABSTRACT

Purpose: Zinc status during gestation affects both maternal and fetal health. The study was designed to investigate maternal zinc status and relate it with dietary zinc and socioeconomic levels in first, second and third trimester pregnant women. **Methods/Patients:** Forty-five [15 for each trimester] pregnant women and thirty non-pregnant women that served as control were recruited for the study. Serum zinc concentrations were determined using atomic absorption spectrometry. From structured questionnaire, information was obtained on age, dietary zinc content, and socioeconomic status [education, occupation]. Zinc status was summarized as mean ± standard deviation. Data were analyzed using Student t- test, analysis of variance (ANOVA), and Chi-square test. $P < 0.05$ was considered significant. **Results:** Only first but not second and third trimester pregnant women featured significantly lower zinc levels compared with control. Non-significant difference in zinc levels were observed when the three trimesters were compared. Of the women in first trimester which featured significantly lower serum zinc level compared with control, all were of high educational status although only < 50% were of high occupational status yet over 70% belong to high dietary zinc sub-group. **Conclusion**: Data obtained from the study revealed that depleted serum zinc level was observed in the first trimester and educational status rather than socioeconomic status played a role in choice of zinc-rich containing food.

Keywords: gestation; first trimester; second trimester; third trimester; serum zinc status; dietary zinc content; socio-economic level

1.0 INTRODUCTION

During pregnancy, progressive physiological changes fundamental to supporting the metabolic demand of the growing fetus increases a woman's micronutrient requirement [1-3]. Characteristic elevations in oxygen consumption, central hemodynamic alterations, and oxidative stress, are essential to fetal development and contribute to the long standing recognition of pregnancy as a vulnerable period which is important in determining life-long health. It is essential to ensure that women receive adequate macro and micro-nutrition prior to and throughout pregnancy to optimize their capacity to manage these physiological challenges and ensure the well-being of the growing fetus. Micronutrient deficiencies have been associated with significantly higher reproductive risks both in the conception period and throughout the course of gestation [4-6] and may include anemia, pregnancy induced hypertension and preeclampsia, fetal growth restriction, labor complications leading to increased maternal and fetal morbidity or mortality [7].

Pregnant women living in developing countries or from low-income areas of developed nations can be exposed to inadequate macro and micro-nutrition [7]. Suboptimal consumption results in lower than average pregnancy weight gains as a result of limited access to and intake of animal products, fruits, vegetables and fortified foods [8]. During pregnancy the increased nutritional demands placed on key maternal physiological systems may exacerbate pre-existing suboptimal micronutrient status and contribute to the increased prevalence of adverse maternal and fetal outcomes in these populations [9].

For many individual pregnant women in the developing world, some of the required micronutrients are derived from diet, which are not optimally consumed. Moreover, sometimes an essential trace element may be obtained or derived from its poor dietary sources. For instance, it is not uncommon for zinc to be derived from plant based diet which are poor sources of this element and which contain high levels of phytate, an important organic compound which inhibits not only the absorption of zinc but other bivalent minerals as well [10].

In developing countries, deficiency of minerals and vitamins in women of reproductive age is recognized as a major public health concern. Pregnant women are the prime target as far as nutritional deficiencies are concerned. The demands imposed by pregnancy involving the growing placenta, fetus and maternal tissues, coupled with associated dietary risks could add up to the effect [11]. This study is aimed at comparing the concentration of serum zinc in first, second and third trimesters of pregnancy and relate them with dietary zinc contents.

2.0 METHODS AND MATERIALS

2.1 Ethical consideration: Ethical clearance was obtained from the Research and Ethics Committee, Ladoke Akintola University of Technology Teaching Hospital, Osogbo, Osun State, Nigeria. Informed consent was obtained from the all study participants. Anonymity of information obtained was maintained.

2.2 Study design: Cross-sectional comparative study

2.3 Sample size: Seventy-five participants consisting of 45 pregnant women across the three trimesters and 30 non-pregnant women. The participants in the four groups were age-matched

2.4 Study site: Antenatal clinics at State Hospital Asubiaro and Osun State Teaching Hospital, both in Osogbo, Nigeria.

2.5 Study population/Inclusion & Exclusion criteria: Research participants consisted of respondent females within the child bearing age range. Included in the study were apparently healthy pregnant women in the three trimesters of pregnancy (test subjects) while apparently health non-pregnant women served as the control group. Meanwhile all pregnant women known to have chronic medical conditions such as human immunodeficiency virus, tuberculosis and chronic renal failure, those on zinc supplementation or any medication capable of altering Zn level were excluded. In addition, those with lifestyles capable of modulating zinc status e.g. smoking, binge drinking and those with obstetrical abnormalities were also excluded.

2.6 Sample collection and trace element estimation: Laboratory wares used were cleansed according to standard procedure as described in Elemental Analysis Manual of United State

Department of Health and Human Services. 5 mL of venous blood was collected from each study participants. Each sample was dispensed into anti-coagulant free bottle and centrifuged for 10 minutes at 1500 x g within 2 hours of collection. Sera obtained were stored in a refrigerator at -20 degree Celsius until required for analysis. The analysis of serum concentration of zinc was done by the Atomic Absorption Spectrophotometry (AAS) using AAnalyst model 400.

2.7 Instrument of data collection: After the questionnaire has been validated, the structured questionnaire was administered by the researcher. It consisted of different sections namely; socio-demography [age, level of education; occupation,/employment status, marital status, family size]; maternal characteristics/ obstetrics information; socio-economic status [high, medium, or low income]. Dietary zinc content was obtained using the classification described by Temiye *et al* [12].

2.8 Classification of Zinc Content in 24-Hour Meal Recall

The zinc contents of 24-hour meal recall and the last meal consumed before blood was taken were classified based on the concentration of zinc in food items consumed by the subject. Thus each food item was classified as containing high, moderate, or low zinc [13, 14]. Meals which contain items such as plantain, red beef, egg, milk, cocoa products, and fish were classified as high zinc content, while beans, cereals made out of maize and rice products contain moderate zinc. Cassava products were classified as having traces or low zinc content [13, 14].

2.9 Statistical analysis: Quantitative variables were summarized as mean ± standard deviation. Student's t-test was used to determine significant difference in serum zinc levels between pregnant [in each of the trimesters] and non-pregnant women. Analysis of variance was used to compare Zn levels of pregnant women in first, second and third trimesters of pregnancy.

Absolute or relative frequency (percentages) of qualitative data was obtained. Relationships between qualitative variables were determined using Chi square test with level of significance set at 0.05 ($p < 0.05$). Data were computer-analyzed using statistical package for social sciences (SPSS) 25.0 version.

3.0 RESULTS AND DISCUSSION

With serum zinc levels of 0.23‡0.052; 0.19‡0.046; 0.25‡0.060; and 0.22‡0.081 (µg/mL) for control, first, second and third trimesters respectively, there was significant difference between control and first trimester (P= .01) but non-significant difference between second (P = .44) or third trimester (p= 0.51) and control. Yet result of the comparison of serum zinc of the three trimesters showed non-significant difference across the three trimesters of pregnancy (F= 2.459; P = .07). The significant lower levels of zinc in first trimester pregnant subjects compared with control are in agreement with various other past studies. Ejezie and Nwagha [15] reported that mean serum zinc levels were significantly lower in pregnancy compared with non-pregnant control. According to Ejezie and Nwagha [15], the degree of decrease continued as gestation progressed with the lowest level in the third trimester, although no such observation was made in the study. Physiological adjustments in intestinal zinc absorption is an important factor in zinc depleted states, the fact that zinc depletion occurred in first trimester subjects shows that such physiologic alteration was not sufficient to meet gestational demand. The difference between the data obtained from the study of Ejezie and Nwagha [15] and the present one may be due to variations in sociodemoraghic parameters of the participants for both study. **It seems as if the age range of participants in Ejezie and Nwagha and the present studies could not have**

contributed to differences in result outcomes because they were similar. Ages of the participants range from 15-44 years.

Quite understandably, decreased zinc level during gestation can be linked with zinc requirement for fetal development and the significant variation within the period of gestation (with respect to trimesters) can be attributed to differences in fetal zinc demand at each stage. The implications of depleted zinc levels in the first trimester pregnant women are diverse on fetal health. Zinc deficiency has been implicated in a wide range of intra-uterine misadventures such as fetal growth restriction resulting either in low birth weight or small for age infants [16]. **Karimi *et al* [17] linked low maternal zinc deficiency not only to growth impairment, but also spontaneous abortion, congenital malformations, delayed immune system development and adverse birth outcomes e.g. premature delivery. The devastating effects of low maternal zinc level is not limited to the fetus, zinc deficiency has been linked with pregnancy-induced hypertension in mothers [18].**

Although, the first trimester is not the period of most rapid growth, it is the time when zinc is mostly required. Some of the events of first trimester for which zinc is needed include development of major organs (heart, kidney, brain, etc) in the embryo [18]. The non-significant differences in levels of zinc at second and third trimesters compared with control warrants further investigation as the second trimester is a time of rapid fetal growth while maximal zinc store during the intra-uterine life is at third trimester, both of which should correspond to increase zinc demand by the fetus.

There is no doubt that fetal zinc demand is always identified as a major cause of zinc depletion during pregnancy. Even in the developed world, pregnant women of different socioeconomic levels feature zinc depletion when compared to their non-pregnant counterparts. Yet in many developing countries a number of other factors have been recognized as causes of zinc depletion during gestation, examples include malnutrition, worm infestation/malabsorption and infectious diseases (e.g. *Plasmodium falciparum*) [19].

Obstetrical events such as morning sickness (nausea, vomiting that is severe enough to become hyperemesis gravidarum) and other symptoms of first trimester pregnancy (e.g. loss of appetite) could have also contributed to the depletion in first trimester subjects. The study of Nyaruhucha *et al*. [20], revealed that as many as 82.8% of pregnant women surveyed reported at least one incidence of morning sickness. The same workers also identified that more than a third and as many as 63.7% of pregnant women survey in Tanzania experienced food aversion and pica respectively during the period of gestation. Most of the food they avoided included fish, meat, egg, and beans; many of which are rich sources of zinc. **Similar observations have been made in Nigerian pregnant women [5]** With respect to pica- soil, ice, and ash were the most common non-food substances eaten. None of which is a healthy source of any essential trace elements. **Other conditions such as smoking and alcohol abuse, capable of altering maternal zinc status and preventing adequate supply of zinc to the fetus are not present in the recruited subjects as they were part of the exclusion criteria [21].**

The use of micronutrient supplementation especially of formulation containing iron could have resulted in significant low level of zinc in the first trimester pregnant subjects compared with control. Interaction, an important characteristic of trace elements is displayed when two bivalent elements are present in ingested food, this is more so when there is overabundance of one trace element at the expense of another. Since they share the same absorption mechanism, it is possible that iron supplementation can result in low level of other bivalent trace metals even those that serve dynamic physiologic roles and are considered as essential [22]. In a study carried out in Nigeria by Ugwu *et al* [23], 65.9% of women were found to comply with intake of iron supplements. However, Hess and King [24] found no adverse effects of maternal iron supplementation on zinc status during pregnancy.

The fact that grains were not a significant source of zinc in the study participants, [obtained from the information contained on the questionnaire] ruled out the influence of high level of dietary phytate on serum zinc status in first trimester pregnant women; phytate is an inhibitor of zinc absorption in the intestine.

More than half 52.0% of the study participants were of medium socioeconomic status, 44.0% were of high socioeconomic status and 4.0% were of low socioeconomic status. More than half 58.7% belonged to high dietary zinc intake group while 41.3% were of medium dietary zinc intake group. Chi-square analysis of these categorical variables reveals no significant relationship between dietary zinc and socioeconomic status ($X^2 = 5.519$; $P = .063$).

Results of the study also revealed that educational rather than socioeconomic status was a better determinant of the quality of zinc content in diet. Even some women who were unemployed, fulltime housewives, or students but with high educational status were found to belong to high dietary zinc content sub-group. That high educational status rather than high economic status contributed to consumption of food rich in zinc suggests that probably curricula at both elementary and higher levels where nutrition is taught as a compulsory subject may have a bearing on this as the women are informed of healthy eating habit during gestation. First trimester women that had significantly lower serum zinc level compared with control were mostly of high educational status although less than half of the individuals were of high occupational status, although 7 out of 10 belonged to high dietary zinc sub-group.

Conclusion:

Data obtained from the study revealed that dietary zinc content of pregnant women recruited for the study varied widely. Although there was no relationship between socioeconomic status and dietary zinc, yet it seemed as if high educational but not economic status corresponded to high dietary zinc intake. Overall, depleted zinc level occurred at first trimester, and there are indications that zinc deficiency during the period of gestation is still a public health issue.

Further study

Further study is required to address the main contributor(s) to low zinc level commonly observed during first trimester of gestation in Nigerian pregnant women. It is also desirable to identify its consequences to maternal health and fetal outcomes. A study of larger sample size is required to clarify or establish the impact higher educational status play in choice of highly nutritious food during the period of gestation.

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