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■ Original Research Article

Zinc Deficiency Among Pregnant Women at A Tertiary Hospital in Katsina

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ABSTRACT

Background: Zinc is an essential micronutrient with many essential functions in the body. Its deficiency in pregnancy has been linked to several adverse pregnancy outcomes. Pregnant women in our environment are at risk of zinc deficiency due to our local diets which contain substances that impair zinc absorption as well as routine iron supplementation which has also been shown to impair zinc absorption. **Aim:** To determine the prevalence of zinc deficiency and its associated factors in our environment.**Methods:** A cross-sectional study was conducted on 305 pregnant women who presented for booking at the ante-natal clinic. A questionnaire was administered to collect relevant information including their socio-demographic data and risk factors for zinc deficiency. Serum zinc was estimated in all patients using a colorimetric technique. The results were entered into SPSS version 20.0 and analyzed. A p-value of <0.05 was considered significant.**Results:** The prevalence of zinc deficiency was found to be 31.1%. It was highest among those aged 10-19 years with a prevalence of 44.4%. There was no significant association found between zinc deficiency and age ($p = 0.422$), socioeconomic class ($p = 0.989$), parity ($p = 0.728$), inter-pregnancy interval ($p = 0.725$), as well as the features studied which included loss of appetite ($p = 0.576$), vomiting ($p = 0.289$), diarrhoea ($p = 0.078$), fever ($p = 0.876$), pallor ($p = 0.591$) and maternal weight ($p = 0.161$). There was no correlation found between zinc deficiency and age ($r = -0.078$, $p = 0.174$), inter-pregnancy interval ($\rho = 0.002$, $p = 0.975$), and maternal weight ($r = 0.078$, $p = 0.173$). **Conclusion:** Zinc deficiency in pregnancy is highly prevalent in our environment occurring in about one in every 3 women. It is highest among pregnant teenagers where it occurs in almost one out of every two. No significant association was found between the risk factors studied, indicating that all pregnant women are likely at risk of zinc deficiency.As this study did not assess dietary intake, future studies in our environment can be done to assess dietary intake of zinc as well as determine the pregnancy outcomes of women with zinc deficiency in pregnancy.

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INTRODUCTION

Zinc is a chemical element with the symbol Zn and atomic number 30. It is an essential micronutrient that is present in cells throughout the body. It has a wide range of catalytic, structural, and regulatory functions in the human body.[1]It participates in all major biochemical pathways and plays multiple roles in the proliferation and differentiation of cells throughout the body; thereby contributing to physical growth, immunity, reproductive function, and neuro-behavioural development.[2] These functions are especially important during pregnancy where there is a developing conceptus. Zinc deficiency in pregnancy has been associated with several adverse pregnancy outcomes including multiple foetal malformations, miscarriages, foetal death, foetal growth restriction and low birth weight, poor neurobehavioral development, increased maternal susceptibility to infections, pre-labour rupture of membranes, preterm labour and pregnancy-induced hypertension.[3-5]

It has been estimated that up to 80% of pregnant women in the world have inadequate zinc intake, with the highest incidence in developing countries.[6]In Nigeria, incidence of19.1% and 45.8% have been reported in different studies.[7,8]

Zinc deficiency during pregnancy can result from decreased intake of zinc due to emesis in pregnancy, physiological haemodilution due to plasma volume expansion which reduces the serum concentration, increased demand from the foetus, and increase in urinary zinc excretion due to increase renal plasma flow.[9] Furthermore, iron supplementation, which is routine during pregnancy, has been found to impair zinc absorption during pregnancy further adding to the risk of zinc deficiency.[10,11] Other drugs that can lower serum zinc levels include quinolones, tetracyclines, and thiazide diuretics.[12-14] Certain conditions have also been found to increase the risk of zinc deficiency. These include diabetes mellitus, sickle cell anaemia, chronic diarrhoea, chronic liver disease, and chronic renal disease.[15]

The normal serum level of zinc in an adult female is 7.0 – 23.0µmol/L, with a recommended daily intake of 12mg during pregnancy.[16,17]Major dietary sources of zinc include animal products such as red meat, poultry, dairy products, and plant products such as whole grains, beans, cereals, and nuts.[17] Although many plants contain zinc, the bioavailability of zinc from plant sources is lower than that from animal sources. This is because phytates, which are present in whole grains and other plant sources of food, bind to zinc and inhibit its absorption.[17]Hyperzincemia is very rare, and consumption of up to 40mg of zinc per day is not associated with any adverse effects.[17]

To the best of our knowledge, no previous studies have been done on zinc deficiency in our environment. Also, routine iron supplementation given to pregnant women coupled with phytates in food may predispose them to lower serum zinc levels in our environment. It is as a result of this that this study will be undertaken to determine the prevalence of zinc deficiency in pregnancy and its determinants. The information obtained will serve as baseline data that may have public health implications in the management of pregnant women in our centre and may also be useful in counselling patients during pregnancy. The study was conducted to determine the prevalence of zinc deficiency in pregnancy as well as the factors associated with zinc deficiency in pregnancy in our centre.

METHODS

The study was conducted at Federal Teaching Hospital (FTH) Katsina, where routine serum zinc testing and supplementation are not done during pregnancy at the antenatal care clinic.

It was a cross-sectional study on women presenting for booking at the antenatal clinic at FTH Katsina. The sample size was calculated using the formula for sample size calculation of single proportions with qualitative outcomes (Fisher's formula) as follows:

$n = Z^2PQ/d^2$

where:

n = required sample size

Z = the standard normal deviation, which is 1.96 at a 95% confidence interval.

P = the prevalence rate which was 19.1% (0.191) from a previous study in Benin.[8]

Q = 1-P, which is 1-0.191, which is 0.809

d = the precision rate, which is 5% (0.05).

Substituting the values, n = 237.4. An attrition rate of 30% was added to take care of questionnaires that might be excluded from analysis due to incomplete or wrong entries as well as blood samples that might be excluded from laboratory analysis due to haemolysis, giving a sample size of 308 which was rounded up to 310.

Eligibility: All consenting pregnant women in the age group of 15-49 years attending the antenatal clinic at FT Katsina were included in the study.

Exclusion criteria

1. Non-consenting pregnant women.

2. Pregnant women known to have chronic medical disorders including chronic liver disease, chronic kidney disease, chronic diarrhoea lasting 2 weeks or more, retroviral disease patients, sickle cell anaemia, diabetes mellitus including gestational diabetes mellitus (who were excluded by asking for risk factors of gestational diabetes mellitus and by doing urinalysis and random blood glucose which are done routinely at the booking clinic).
3. Pregnant women who had been on iron supplementation before presenting for booking.
4. Pregnant women who had been on any medication (such as quinolones, tetracyclines, angiotensin converting enzyme inhibitors, thiazide diuretics, cisplatin) that are known to interact with zinc within the last 2 weeks of presentation, or on any medication containing zinc during the index pregnancy.

Sampling Technique and Recruitment

Purposeful sampling technique was used in this study. Eligible patients were counselled about the study at the clinic and interviewed to ensure the absence of all exclusion criteria, then recruited into the study after written informed consent was obtained. Patients were serially recruited until the desired sample size was obtained.

Data collection: Following recruitment, the history was taken to obtain the patient's biodata, obstetric history, and history of symptoms that may affect serum zinc levels. The socioeconomic class was derived using the socioeconomic classification by Oyedeji.[18] Clinical examination was done to check for pallor and record the patient's weight in kilograms using a digital scale and height in meters using a stadiometer. Each patient was given a serial number which was recorded in her questionnaire and sample bottle for identification. A research assistant (laboratory technician) collected 10 ml of blood under an aseptic technique from a suitable forearm vein for serum zinc estimation as well as routine antenatal investigations. Immediately after blood collection,5mlwere transferred to a plain bottle for zinc estimation, while the other 5mls were used for routine antenatal investigations. The blood was sent to the chemical pathology laboratory in FTH Katsina, allowed to clot, and then centrifuged at a relative centrifugal force of 1200Xg for 10 minutes. The separated serum was transferred to plain bottles for immediate analysis of serum zinc or stored at -20^{0}C for analysis at a later time.

Serum Zinc Analysis: Quantitative measurement of serum zinc was done using the colorimetric method. The serum zinc reagent with lot No 85456 made by Centronic GmbH (Germany) was used. The test was carried out according to the manufacturer's instructions. One thousand microliters) 1000 µl of working reagents were put inside each test tube, then fifty microliters 50 µl of standard samples were added and then the solution was mixed and incubated for 10 minutes at 37ºC. The zinc bound to the ligand in the reaction forming 2-(5-brom-2-pyridylazo)-5-N-propyl-N-sulfopropylamino)-phenol which was a red chelate complex.[16] The increase in absorbance was measured at 560nm using a spectrophotometer, and this absorbance was proportional to the concentration of total zinc in the sample. Serum zinc concentration (µmol/L) was calculated as shown below-

$$\frac{\text{the concentration of standard X Absorbance of sample}}{absorbance\ of\ standard}$$

In this study, patients with serum zinc levels of 7.0 – 23.0µmol/L were considered to have normal zinc levels, while those with levels less than 7.0µmol/L were considered to be zinc deficient and those with levels more than 23.0µmol/L were considered to have high levels.

Statistical analysis: This was done using SPSS statistical software version 20.0. Categorical data were presented as numbers and percentages and compared using Chi-square or Fisher's exact test for statistically significant differences. Continuous variables were summarized as mean and standard deviation if normally distributed or as median and inter-quartile range if skewed. They were compared using the student-T test or Mann-Whitney U test as appropriate. Pearson's correlation and Spearman's correlation were used to determine the relationship between age, inter-pregnancy interval, and weight with zinc deficiency as appropriate. A p-value of less than 0.05 was considered statistically significant.

Ethical clearance: The ethical clearance was obtained from the Health Research Ethics Committee of FT Katsina (FMCNHREC.REG.N003/082012). The study objective was explained to the patients, and confidentiality and anonymity was assured. Written informed consent was obtained from all patients before participation. Patients were informed that participation was voluntary, and they could terminate their participation at any time they wish. They were also informed that failure to consent to the study will not affect their routine care and will have no consequences at all. All cost of the serum zinc estimation was paid by the researcher with no

additional cost to patients. To avoid undue discomfort from needle prick, blood samples were collected at the same time when blood samples for routine antenatal booking investigations were done.

Limitation: The daily zinc intake was not determined.

RESULTS

Out of 310 patients recruited, 5 were excluded due to incomplete information on the questionnaires and 305 were included in the final analysis, giving a response rate of 98.4%. The ages of the respondents ranged from 15 years to 48 years with a mean of 28.2 (± 5.82) years. About 60% were in the second decade

Table 1: Socio-Demographic Characteristics of Patients

Variables	Frequency	Percentage (%)
Age (years)		
10-19	9	3.0
20-29	184	60.3
30-39	98	32.1
40-49	14	4.6
Total	**305**	**100.0**
Tribe		
Hausa/Fulani	254	83.3
Igbo	21	6.9
Yoruba	7	2.3
Others*	23	7.5
Total	**305**	**100.0**
Religion		
Islam	263	86.2
Christianity	42	13.8
Total	**305**	**100.0**
Educational status		
None	4	1.3
Quranic	18	5.9
Primary	19	6.2
Secondary	136	44.6
Tertiary/postgraduate	128	42.0
Total	**305**	**100.0**
Occupation		
Housewife	201	65.9
Business/trading	44	14.4
Civil servant	21	6.9
Teacher	16	5.2
Student	14	4.6
Tailor	8	2.6
Journalist	1	0.3
Total	**305**	**100.0**
Socio-economic class		
Class 1	19	6.2
Class 2	161	52.8
Class 3	83	27.2
Class 4	36	11.8
Class 5	6	2.0
Total	**305**	**100.0**

Others* Evie, Jangu, Kanuri, Kataf, Koro, Gwari, Egede, Idoma, Jawara, Ebira
Age range = 15 – 48 years (33 years), Mean ± SD = 28.2 ± 5.82 years

Table 2: Obstetric Characteristics of Patients

Variable	Frequency	Percentage (%)
Parity		
Nulliparous (0)	63	20.6
Multiparous (1 - 4)	172	56.4
Grandmultiparous ( )	70	23.0
Total	**305**	**100.0**
Previous Miscarriage		
0	247	81.0
1	40	13.1
2	13	4.3
	5	1.6
Total	**305**	**100.0**
Inter-pregnancy interval		
Nil	63	20.6
< 6months	9	3.0
6 24 months	87	28.5
25 48 months	96	31.5
49 59 months	7	2.3
60 months	43	14.1
Total	**305**	**100.0**
Estimated Gestational Age		
1st Trimester (< 13 weeks)	34	11.1
2nd Trimester (13 - < 26weeks)	192	63.0
3rd Trimester (26 weeks)	79	25.9
Total	**305**	**100.0**

Estimated gestational age range = 6 – 36 weeks (30 weeks), Mean ± SD = 21.9 ± 6.50 weeks

Table 3: Serum Zinc Status of Patients

Variable	Frequency	Percentage (%)
Serum Zinc level		
Low (<7µmol/L)	95	31.1
Normal (7-23µmol/L)	206	67.5
High (>23µmol/L)	4	1.3
Total	**305**	**100.0**

Serum zinc range = 2.4 – 39.5µmol/L (37.1µmol/L), Mean ± SD = 9.4 ± 4.725µmol/L

of life. Over 80% of the respondents were Hausas and Muslims. A majority had a secondary level of education (44.6%) and about two-thirds were housewives. Over half of the patients (52.8%) were in Social Class II. The socio-demographic characteristics of the patients are shown in Table 1.

Table 2 shows the obstetric characteristics of the patients. The majority were multiparous (56.4%). A majority had never had a previous miscarriage (81.0%) while 1.6% had at least 3 previous miscarriages. About one third (31.5%) of the patients had an inter-pregnancy interval of 25-48 months. At recruitment, only 11.1% of the

patients were found to be in the first trimester of pregnancy while 63.0% were in the second trimester and 25.9% were in the third trimester of pregnancy. The mean gestational age at presentation was 21.9 (± 6.50)
weeks.

Table 3 shows the results of the analysis of the serum zinc levels of the patients. The prevalence of zinc deficiency was found to be 31.1%. About two-thirds (67.5%) had normal serum zinc levels while 1.3% were found to have elevated levels of zinc.

The prevalence of zinc deficiency was highest among those aged 10-19 years (44.4%). It was 31.5% in the 20–29-year age group; 30.6% in the 30–39-year age group and 21.4% among those aged 40-49 years.

Table 4 shows the factors associated with zinc deficiency. There was no significant association found between zinc deficiency and age, socioeconomic class, parity, or inter-pregnancy interval, as well as the features studied which included loss of appetite, vomiting, diarrhoea, fever, pallor, and maternal weight. There was no correlation found between zinc deficiency and age ($r = -0.078$, $p = 0.174$), inter-pregnancy interval ($\rho = 0.002$, $p = 0.975$), and maternal weight ($r = 0.078$, $p = 0.173$).

Table 4: Factors Associated With Zinc Deficiency

Variable	Zinc Status		Test statistic	P value*
	Deficient n = 95	Not deficient n = 210		
Sociodemographic Factors				
Mean age (±SD) years	27.8±5.52	28.4±6.00	t = -0.804	0.422
Socio-economic class				
Class 1	6 (6.3%)	13 (6.2%)		
Class 2	52 (54.7%)	109 (51.9%)	$X^2 = 0.313$	0.989
Class 3	24 (25.3%)	59 (28.1%)		
Class 4	11 (11.6%)	25 (11.9%)		
Class 5	2 (2.1%)	4 (1.9%)		
Obstetric Factors				
Parity				
Nulliparous	22 (23.2%)	41 (19.6%)		
Multiparous	53 (55.8%)	118 (56.5%)	$X^2 = 0.634$	0.728
Grand multiparous	20 (21.1%)	50 (23.9%)		
Median inter-pregnancy interval (IQR) months	24 (37)	25 (22)	U = 9750.5	0.752
Symptoms/Signs				
Loss of appetite	27 (28.4%)	53 (25.2%)	$X^2 = 0.342$	0.576
Vomiting	16 (16.8%)	47 (22.4%)	$X^2 = 1.224$	0.289
Diarrhoea	4 (4.2%)	2 (1.0%)	Fisher's exact	0.078
Fever	19 (20.0%)	40 (19.9%)	$X^2 = 0.380$	0.876
Pallor	2 (2.1%)	2 (1.0%)	Fisher's exact	0.591
Mean weight (±SD) years	65.7 ± 13.05	68.6 ± 17.41	t = -1.406	0.161

DISCUSSION

The study showed that almost one-third (31.1%) of the study population had zinc deficiency in pregnancy. According to the International Zinc Nutrition Consultative Group (IZiNCG), zinc deficiency becomes a public health concern when the prevalence is more than 20%.[19] Based on this, the prevalence of 31.1% found in this study makes zinc deficiency in our environment a public health concern. The high prevalence found in this study was lower than the prevalence of 45.8% reported in the South-eastern part of Nigeria,[7] but higher than 19.1% and 22.5% reported in the South-south region of Nigeria.[8,21] These differences observed could be due to differences in diets and food composition among women living in different parts of Nigeria. The lower prevalence of 19.1% reported in Benin might additionally be because most (over three quarters) of the women in the studied population had tertiary education and up to two-thirds belonged to socio-economic class I, as opposed to this study where less than half of the study population had tertiary education and less than 10% belonged to socio-economic class I, indicating a generally higher socio-economic level among the women studied in the Benin study. It was therefore not surprising that the mean serum zinc level of 9.4 µmol/L found in this study was much lower than 61.5µmol/L (100.5µg/dl) found in the study in Benin in South-South Nigeria.[8]Socio-cultural and nutritional differences may also explain why a much lower prevalence of zinc deficiency of 9.0% was found in a study in Ireland.[22]

A higher prevalence of zinc deficiency in pregnancy of 53.3% was also reported in Ethiopia.[23]This higher value may be because the Ethiopian study was a community-based study as opposed to this hospital-based study. Also, it may be due to differences in dietary intake between the study groups. Furthermore, the pregnant women who were already on iron supplementation were not excluded from the Ethiopian study, and iron has been found to reduce serum zinc levels by impairing zinc absorption.[10,11]

The highest prevalence of zinc deficiency was found among teenagers 10-19 years, with almost one in every two women being zinc deficient. This is similar to the findings from other parts of Nigeria where zinc deficiency were more prevalent in younger age groups.[7,8] This finding might be reflective of the general micronutrient deficiencies reported in pregnant adolescents which could be due to maternal-foetal competition for nutrients, increased risk of hyperemesis, and poor food intake among them.[24]

In this study, there was no significant relationship found between zinc deficiency and socioeconomic class, parity, inter-pregnancy interval, or any of the features that were thought to be associated with zinc deficiency. This is in contrast with findings from the Southern parts of Nigeria. The study in Benin did not find any association between zinc deficiency and maternal

age and parity similar to our study, but they found a significant association between zinc deficiency and low maternal weight and low socio-economic class.[8] In the Ethiopian study, a significant association was found between zinc deficiency and advanced maternal age, grandmaternity, low socio-economic status, and an inter-pregnancy interval of 6-23 months.[23]The Ethiopian study was conducted among women in the rural area and this could have accounted for the differences in findings with our study.

CONCLUSION

Zinc deficiency in pregnancy is highly prevalent in our environment occurring in about one in every 3 women. It is highest among pregnant teenagers where it occurs in almost one out of every two. No significant association was found between the risk factors studied, indicating all pregnant women are likely at risk of zinc deficiency. As this study did not assess dietary intake, future studies in our environment can be done to assess dietary intake of zinc as well as determine the pregnancy outcomes of women with zinc deficiency in pregnancy.

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