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Comparative Study of Serum Iron, Total Iron Binding Capacity and Transferrin Saturation Fraction Levels in Two Groups of Nigerians in Different Socio-Economic Classes

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Abstract: An analysis of serum iron concentration, total iron-binding capacity and transferrin saturation fraction using standard procedures on apparently healthy adults, 100 males and 100 females revealed the following: (1) A high degree of variability exists within our adults' serum iron, total iron-binding capacity and transferrin saturation fraction whether in rural or urban areas. (2) The analysis of the data for sex differences showed that the adult males have higher serum iron levels, slightly lower total iron-binding capacities and greater transferrin saturation fraction levels than in the females. (3) Age at this period does not exert any significant influence on these iron parameters in adult life for both sexes. This work has shown that the levels of serum iron, total iron binding capacity and transferrin saturation fraction in adults living in Calabar were higher than those in Ekori, both in Cross River state It is desired that further studies in the normal variability of these parameters in other parts of Nigeria be carried out.

Key words: Serum iron, iron-binding capacity, transferrin saturation fraction

Introduction

Iron is very essential for most living things. It is a component of haemoglobin, myoglobin as well as a number of enzymes such as cytochrome oxidase, xanthin oxidase, peroxidase and catalase (Lynch and Baynes, 1996). Iron is derived solely from dietary ingestion and its present in red meat, liver, eggs, green leafy vegetables, plantain, bananas and fortified cereal products (Gavin *et al*., 1994).

Transportation of iron is through the mucosal cells of the upper small intestine by the plasma protein transferrin. The synthesis of transferrin occurs primarily in the liver and appears to be related to the level of storage iron (Yip and Dallman, 1996).

Serum Iron (SI), Total Iron Binding Capacity (TIBC), percentage transferring saturation and serum ferritin in apparently healthy population groups have been reported to vary significantly from one country to another (Oluboyede *et al*., 1983; Milman and Cohn, 1984; Usanga, 1990; Usanga *et al*., 1994; Looker and Clifford, 1998; Ahlan and Oluboyede, 2001). Besides the studies of Usanga, 1990 and Usanga *et al*., 1994, respectively there are no other reports on these values from people living in Cross River state. This study was undertaken because of limited information available on these parameters and coupled with the fact that reference values from other parts of the world and Nigeria which have different environmental conditions and nutritional habits from Cross-River are currently used to determine the values of these parameters in our laboratory.

This work was carried out in Calabar and Ekori in Cross-River state of Nigeria. Cross-River State is in south eastern region of Nigeria. The Capital is Calabar with eighteen (18) local government areas. The State has tropical humid climate with dry and wet seasons. Cross-River is rich in agricultural resources such as livestock, sea food, vegetables and minerals. Calabar the State capital is a Metropolitan city with good facilities and amenities. Majority of the people living in Calabar are civil servants and business men. Ekori is a rural town in Yakurr local government area of Cross-River State. The people are mainly peasant farmers with low income resources.

Materials and Methods

Blood samples were collected from 200 healthy Nigerian adults comprising 100 males and 100 females between the ages of 20-50 years, living in Cross River State of Nigeria. The subjects were made up of two groups; rural based adults from Ekori village in Yakurr L.G.A of Cross River State and urban based adults from Calabar the capital city of Cross River State. The selection of the volunteers who were apparently healthy individuals was based on the criteria: age range between 20-50 years; no history of drug usage (including vitamins/iron, antibiotics); no history of blood transfusion in the previous 6 months and no recent history of blood loss. Additional criteria for females included not being pregnant and not lactating or menstruating at the time of blood collection. The blood was drawn in the morning between 8 and 11 am. The volunteers were selected from farmers, traders, civil servants, business men and students from the general public who were drawn from low, average and high socio-economic classes.

Table 1: Serum iron, TIBC and Transferrin saturation fraction levels of apparently healthy adult subjects in Cross River State

Parameters	(n = 200)
Serum iron (µmol/L)	16.1±7.5
TIBC (µmol/L)	66.5±4.2
Transferrin saturation fraction %	24.5±3.9

Result expressed as mean±SD, n = Number of subjects studied

Table 2: Serum iron, TIBC and Transferrin saturation fraction levels of apparently healthy adults in Ekori and Calabar volunters

Parameters	Ekori (n = 100)	Calabar (n = 100)
Serum iron (µmol/L)	15.4±2.2	16.9±1.9
TIBC (µmol/L)	67.3±4.1	65.5±4.3
Transferrin saturation %	22.9±3.4	26.1±2.8

Result expressed as mean±SD, n = Number of subjects studied

While seated in an upright position, five millitres (5 mL) of venous blood was obtained from volunteers and three millitres (3 mL) of it was dispensed into clean, iron free screw-capped plain glass bottle and allowed to stand at room temperature until separation of the serum was done by centrifugation. The separated sera was kept at 20C until analyses was done. The determination of serum iron, total iron binding capacity and calculation of transferrin saturation fraction from the value of serum iron and total iron binding capacity was done.

Measurement of serum Iron: Serum iron test kit was purchased from Pharm-tec Petro-Chemical Germany for the assay of serum iron and manufacturer's instructions were followed. Briefly, 50ul each of test serum, iron standard and distilled water were placed into three glass test tubes labeled test, standard and blank respectively and 1 mL of iron reagent (CAB reagent) added. The solutions were mixed well and incubated for 15 minutes at room temperature. The absorbance of the test sample and that of the standard were measured against the reagent blank within 60 minutes at 623nm using optima SP 300 spectrophotometer.

Measurement of Total Iron Binding Capacity (TIBC): The TIBC kit was purchased from Human diagnostic GmbH, Germany and manufacture's instructions followed. TIBC was determined by placing 1.0 mL of iron solution reagent into a labeled iron free test tube followed by addition of 0.5 mL of serum sample. The content of the test tube was mixed well and after 5 minutes, 0.25g of aluminum oxide was added. The test tube was capped and placed on a rotator to mix for 10 minutes after which the test tube was centrifuged for 1 minute at 5,000rpm to obtain a clear supernatant that was transferred to another iron free test tube and serum iron estimated as described above.

Calculation of Transferrin saturation fraction (TRSF): Transferrin saturation fraction was calculated according to the following formulae

$$TRSF = \frac{\text{serum Iron concentration} \times 100}{TIBC}$$

The statistical analysis of the data was carried out using SPSS 10.0 programm (1995). Arithmetic mean, standard deviation and student's t test were used to determine the statistical significance of the difference in the mean values for Calabar and Ekori volunteer males and females. A $p<0.05$ was considered significant.

Results

Mean values of Serum Iron (SI), Total Iron Binding Capacity (TIBC) and transferrin saturation fraction for adults living in Cross-River State is shown in Table 1. Values of SI, TIBC and transferrin saturation fraction for males and females in Ekori and Calabar are shown in Table 2. The mean SI values in Ekori and Calabar males were significantly higher than in the females ($p<0.05$) Table 3. Mean values of the TIBC were higher in females than in males. The differences between the two sexes were statistically significant ($p<0.05$). The transferrin saturation fraction values were higher in males than in females and the differences were statistically significant ($p<0.05$). The relationship between three age groups (20-30 years) (31-40 years) (41-50 years) and serum iron, total iron binding capacity and transferrin saturation fraction showed no significant difference ($p>0.05$) (Table 4).

Discussion

The value of Serum Iron (SI), Total Iron Binding Capacity (TIBC) and transferrin saturation fraction obtained for people living in Cross River state (both sexes) in this study were 16.1±7.5µmol/L, 66.5±4.2µmol/L and 24.5±3.9% respectively. The volunteers residing in the rural town of Ekori had significantly lower SI and transferrin saturation fraction with higher TIBC than their counterparts in Calabar metropolis. The implication of this finding is that some degrees of variability exist in our adults living in the rural area of Ekori. This may be attributed to low levels of dietary iron intake, low socioeconomic status, poor health facilities and parasitic infections (Ahlan and Oluboyede, 2001).

Mean values on SI and transferrin saturation fraction among healthy Ekori and Calabar volunteers of both sexes were similar to Ahlan and Baynes, 2001 but differed from Oluboyede *et al.*, 1983. Oluboyede reported higher TIBC and transferrin saturation fraction values than those in our study for both Ekori and Calabar volunteers. The explanation for the differences may be due to the small number of subjects investigated by Oluboyede *et al.*, 1983. While the authors worked on 121 subjects (both sexes), we investigated 200 volunteers of both sexes.

On the other hand, values obtained by Usanga *et al.*, 1994, for SI and transferrin saturation fraction among healthy adult non-pregnant females in Calabar, were

Table 3: Serum iron, TIBC and Transferrin saturation fraction levels of Ekori and Calabar subjects based on sex

	Ekori		Calabar	
Parameters	Males (n = 60)	Females (n = 40)	Males (n = 64)	Females (n = 36)
Serum iron (umol/L)	16.5±1.7	14.1±2.0	18.1±1.6	15.6±1.7
TIBC (umol/L)	66.5±3.2	68.5±4.6	62.9±4.3	67.3±2.4
Trans. Sat. (%)	25.0±3.3	20.8±3.5	28.9±2.9	23.4±2.8

ANOVA p<0.05, Result expressed as mean±SD, n = Number of subjects studied

Table 4: Serum iron, TIBC and Transferrin saturation fraction levels of Ekori and Calabar volunteers based on age

Ekori				Calabar			
Age group (years)	Serum iron (µmol/L)	TIBC (µmol/L)	Transferrin saturation (%)	Age group (years)	Serum iron (µmol/L)	TIBC (µmol/L)	Transferrin saturation (%)
20-30 (n=50)	15.5±2.3	67.9±2.9	22.3±3.6	20-30 (n = 60)	16.9±1.9	64.2±4.6	2 26.5±4.2
31-40 (n=39)	15.4±2.0	65.8±4.7	24.1±3.7	31-40 (n=32)	17.3±2.1	64.5±4.7	27.1±4.0
41-50 (n=11)	16.4±2.0	67.5±3.3	24.3±3.6	41-50 (n=8)	18.0±1.5	64.0±2.2	28.1±2.1

ANOVA p>0.05, Result expressed as mean±SD, n = Number of subjects studied

higher than values of our female volunteers from Calabar. The authors worked on 81 adult non-pregnant females who were students and staff of the university of Calabar and University of Calabar Teaching hospital (UCTH) Calabar who belong to the elite class, while we worked on 100 non-pregnant females from the general public who belonged to low, middle and higher socio-economic class. This may be the reason for the differences in our values.

The female subjects were observed to have lower SI, transferrin Saturation fraction and higher TIBC in both Ekori and Calabar subjects when compared with their male counterparts. This is understandably so due to monthly blood loss experienced by the females in this age range.

The volunteers from Ekori and Calabar were grouped as follows, 20-30 years, 31-40 years and 41-50 and their SI, TIBC and transferrin saturation fraction levels compared. The differences observed were not significant thus indicating that at these age ranges, the SI, TIBC and transferrin saturation fraction do not change. In Conclusion, this work has shown that there are changes in SI, TIBC and transferrin saturation fraction in sera of people living in urban and rural areas within the same state.

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