

Study of Iron Status Indicators in Different Phases of Menstrual Cycle in Females of Lower Socio-Economic Group.

Shipra Chandra¹, Namrata Kaushik², Narendra Gupta³

¹Senior Resident, Dept. of Physiology, All India Institute of Medical Sciences, New Delhi.

²Junior Resident, Dept. of Physiology, Rohilkhand Medical College and Hospital, Bareilly, U.P.

³Associate Professor, Dept. of Physiology, Rohilkhand Medical College and Hospital, Bareilly, U.P.

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ABSTRACT

Background: Iron requirements are increased in adolescent girls with growth and the onset of menarche and remain high in women until menopause. **Methods:** We conducted a study on 18-25 years females of lower socioeconomic status as per the Modified Kuppaswamy's Scale to study the effect of the phases of menstrual cycle & socioeconomic class on the iron status indicators (Hb, Serum Iron, TIBC, MCV & TS%). Menstrual phases were defined and blood samples were drawn from all the girls in all the 3 phases (menstrual, follicular & luteal) and Hb, Serum iron & Total iron binding capacity were assessed on a semi-auto-analyzer & MCV was estimated using a fully automated CBC machine. Transferrin Saturation was derived as Serum Iron / TIBC × 100. **Results:** We found that the values of iron status indicators varied significantly according to the menstrual cycle, with values highest during the luteal phase and lowest during the menstrual phase. From our observations we can conclude that the nutritional status (assessed by the height, weight & BMI) and the iron status indicators both are significantly lower in the females of lower SES. Hence, socio-economic class has a major determining role on an individual's health. **Conclusion:** The effect of hormonal fluctuations during the menstrual cycle also has a part to play in the variation of iron status measures, which has to be considered while measuring them in a female during her reproductive years.

Keywords: Iron status indicators (ISI), Menstrual Cycle, Socioeconomic Status (SES).

INTRODUCTION

In a tropical country like India where infestations and infections are a common occurrence in one's life combined with limited quality food intake, faulty cooking and eating methods, the iron as well as the overall nutritional status of females remains often compromised, especially in the girls of lower socioeconomic (SES).

In women, iron deficiency has been associated with low dietary iron intake and high levels of physical activity. It has serious implications in terms of increased morbidity and mortality rates in vulnerable groups, impaired growth and cognitive abilities in children and reduced work capacity and poor obstetric performance in adult women.^[1,2]

Name & Address of Corresponding Author

Dr. Shipra Chandra
Senior Resident,
Dept. of Physiology,
All India Institute of Medical Sciences,
New Delhi.

In developing nations, iron deficiency (ID) & iron deficiency anemia (IDA) occur most often in

premenopausal women, mainly because of poor dietary intake and the regular loss of blood during menstruation.^[3] The mean menstrual iron loss, averaged over the entire menstrual cycle of 28 days, is about 0.56 mg/day. The marked variation of menstrual losses is a great nutritional problem. ^[4] In boys, body iron stores may be increased during and after their rapid growth period, whereas in girls, iron stores remain low during the whole pubertal period. Besides growth spurt menstrual loss is another cause for lower iron status in post pubertal females.^[5] SES and health are directly correlated across the world. Adult health outcomes follow a spectrum that closely matches social status, and this gradient of health status persists at each step on the social ladder. Though the nutritional status plays a vital role in determining the iron status, it can also get affected by non-nutritional factors as well. In women of reproductive age, potential confounding factors include physiological changes that occur during the menstrual cycle, such as fluctuations in fluid volume, blood loss and significant iron loss associated with it, may cause variations in iron status indicators.^[6] It has been seen that women who become pregnant while anemic are at higher risk of preterm delivery, maternal death, impaired fetal

growth, low birth weight and increased neonatal mortality.^[7]

So, first it is very important to assess the iron status of all the females in reproductive age group and specially, in females of lower SES as they are most prone for low iron stores, along-with day to day heavy physical labor. Also, while we conduct a nation-wide survey to assess the nutritional status, it is of foremost importance to assess, keeping in mind all the factors that can alter our results, specially menstrual cycle in females, girls at menarche, women right after child birth, women suffering from irregular/heavy menstrual cycle due to any gynecological disorder, post traumatic and post major surgical patients, people suffering from bleeding disorders. The present study was designed to study the variations in iron-status measures in unmarried females of lower socio-economic group aged 18-25 years.

Aims & Objectives

- To study the iron status indicators in females of lower socioeconomic groups aged 18-25 years.
- To determine whether normal physiological changes associated with menstrual cycle affect the iron status indicators in females of lower socioeconomic groups aged 18-25 years.

MATERIALS AND METHODS

The study was conducted at Department of Physiology, Moti Lal Nehru Medical College, Allahabad (U.P.) between year 2011 to 2012. Approval from the institute's ethical committee was taken and written informed consent was taken from each girl participating in the study.

Inclusion criteria (n=50)

- Young adult unmarried females of age 18-25 years.
- Living in urban slums
- Belonging to low SES (social class 4&5 of modified kuppuswamy scale)
- Having normal menstrual cycle of 25-32 days
- Not on medication or hormonal supplements

Exclusion Criteria

The following were excluded from the study

- Non-compliant subjects
- Irregular menstrual cycle
- Any significant previous illness
- Any bleeding disorder or hemoglobinopathy
- History of major surgery, accident or blood transfusion
- Suffering from or suffered from any gynecological or hormonal disorder
- Family history of: Any blood related disorders/Menstrual irregularities/Infertility/Cancer

of female reproductive organs/Any gynecological disorder.

Evaluation After taking the informed consent, applying exclusion and inclusion criteria the detailed history was taken including name, age and the following:-

- a) Dietary habits-veg./non veg. with qualification and quantification of the daily intake
- b) Menstrual history with: Age at menarche & following phase definition:
 1. Menstrual phase: day 1-5, menstruating at the time of survey
 2. Follicular phase: 6-16 days after menstruation
 3. Luteal phase: 17-30 days after menstruation.
- c) Detailed history regarding – Regularity/Flow/Debilitating pain/Cyclical mastalgia/Last menstrual period.

Complete general & systemic examination was carried out on each subject as per the standard guidelines. The following measurements were carried out on each subject:

1. Anthropometry: Height, Weight and BMI
2. Iron status indicators:
 - a. Serum Iron^[8]: 11.6-31.7 µmol/lit in males & 9.0-30.4 µmol/lit in females.
 - b. Total Iron Binding Capacity^[8]: 45 – 66 µmol/lit
 - c. Hemoglobin^[9]: 13.5 – 18 gm/dl in males & 11.5 – 16 gm/dl in females.
 - d. Transferrin Saturation^[8]: 20 – 50 % in males & 15 – 50% in females.
 - e. Mean Corpuscular Volume^[9]: 74 - 95 µm³

Intra-cubital venous blood (5ml) was collected from the subjects. The blood was allowed to stand for 60 minutes in incubator at 37°C. After that serum was obtained by centrifugation. Fresh serum was used for SI & TIBC, fresh whole blood for Hb & MCV determination.

Estimation of serum iron and TIBC was done by ferrozine method (magnesium carbonate) obtaining the absorbance using the semi-auto-analyzer by ARTOS established in the Department of Physiology M.L.N.M.C Allahabad.



Hemoglobin estimation was done by Cyan-met-hemoglobin method (Drabkin's reagent), obtaining the absorbance using the semi-auto-analyzer

$$\text{Transferrin saturation} = \text{Serum Iron} / \text{TIBC} \times 100$$

Estimation of MCV was done by fully automated complete blood count machine (Medonic M series) installed in the Department of Pathology, M.L.N.

Medical College, Allahabad. Fresh un-clotted whole blood was used for the MCV estimation.

Statistical Analysis: The data obtained in the study group was expressed as the mean \pm standard deviation. Statistical analysis was done with the help of statistical software SPSS 17.0. The p value of < 0.05 was considered as statistically significant.

RESULTS

Our results show that the iron status indicators are significantly lower in the present study group as compared to normal cut offs for the age matched controls. The present results confirm the difference of the social class on the nutritional and health status of young adult females as shown by Gupta et al 2009¹⁰. The significantly lower weight and BMI of these girls belonging to the lower SES is attributed to the poverty and the social class of the subjects, also supported by K. Prashant et al 2009^[11], Sanjeev M C et al 2008^[12] and ME Bentley et al 2003^[13].

Significant correlation was found between the iron status indicators during different phases of the menstrual cycle. Concentrations of Hb were lowest for girls in the menstrual phase and highest for girls in the luteal phase. Mean values of both SI and TS were also significantly associated with phases of the menstrual cycle, their values were lowest for girls in the menstrual phase and highest for girls in the luteal phase. The patterns of TIBC values were opposite to those observed for Hb, SI, and TS. Measures of TIBC were highest for girls whose blood was drawn in the menstrual phase and lowest during the luteal phase. MCV values were different only during the follicular phase, significantly lower than the values observed during the menstrual phase. MCV values were only slightly different during the luteal phase from the menstrual phase (not significant). So, we found significant differences in iron status indicators, varying in accordance to the menstrual cycle, with values highest during the luteal phase and lowest during the menstrual phase.

Table 1: Mean & standard deviation of different parameters in study group.

S. No.	Parameters	Study group (Mean \pm S.D.)
1	Age (yrs.)	18.36 \pm 0.53
2	Height (cms)	155.90 \pm 3.99
3	Weight(kgs)	41.08 \pm 3.77
4	BMI(kg/m ²)	16.85 \pm 1.39
5	SES	4.56 \pm 0.49

Table 2: Mean & standard deviation of iron status indicators during menstrual phase.

S. No.	Parameters	Study Group (Mean \pm S.D.)
1	Hemoglobin (gm/dlit)	8.44 \pm 0.85
2	Serum Iron (μ mol/lit)	11.73 \pm 0.87
3	TIBC (μ mol/lit)	68.01 \pm 1.00
4	TS%	17.23 \pm 1.49
5	MCV	86.21 \pm 1.96

Table 3: Mean & standard deviation of iron status indicators during follicular phase

S. No.	Parameters	Study Group (Mean \pm S.D.)
1	Hemoglobin (gm/dlit)	8.73 \pm 0.85
2	Serum Iron (μ mol/lit)	12.42 \pm 0.89
3	TIBC (μ mol/lit)	67.30 \pm 0.98
4	TS%	18.44 \pm 1.55
5	MCV	85.12 \pm 1.97

Table 4: Mean and standard deviation of iron status indicators during luteal phase

S. No.	Parameters	Study Group (Mean \pm S.D.)
1	Hemoglobin (gm/dlit)	9.04 \pm 0.86
2	Serum Iron (μ mol/lit)	13.07 \pm 0.86
3	TIBC (μ mol/lit)	66.58 \pm 0.97
4	TS%	19.61 \pm 1.52
5	MCV	85.97 \pm 1.97

DISCUSSION

Our findings suggest that females in the reproductive age group (specially, during the active menstrual phase) are more prone to lower ISI as compared to women not actively menstruating. Also, socio-economic class has a major role to play in determining the nutritional status of these young adult girls and our findings are also confirmed by G.N. Elemo et al^[14], Mc Clung J.P et al^[15], Leng Huat Foo et al^[16] and M Ferrari et al^[17].

The rhythms of ovarian hormones during the course of the menstrual cycle influence the secretion of hormones that control the volume and content of the vascular space. Thus changes in plasma volume and rise in plasma protein concentrations are linked to the normal course of estrogen and progesterone fluctuations during the menstrual cycle.^[18] In our study we did not directly measure changes in plasma volume, but our observations are in accordance with the well-known hormonal changes of the menstrual cycle and their known influence on hemo-concentration & dilution. Hemo-concentration due to estrogen, mediated changes in plasma volume or increased synthesis or secretion of plasma proteins, might explain the mechanism for higher iron-status values during the luteal phase. An increase in plasma progesterone concentrations also occurs during the luteal phase which has a natriuretic effect due to aldosterone antagonism, resulting in plasma loss of sodium and water.^[19] Progesterone may also influence hemo-concentration during the early to mid-luteal phase when its concentrations peak. The fall in progesterone during the luteal phase is associated with a sharp rise in aldosterone activity observed few days before the onset of menses manifesting as weight increase, edema & hemodilution. Thus, the hormone-associated changes in plasma volume and plasma protein concentration occurring during course of the menstrual cycle offer a possible mechanism to explain differences in the values of iron-status indicators that we observed at different phases of the cycle.

CONCLUSION

From our observations we can conclude that the anthropometric measures (height, weight & BMI) and the iron status indicators are significantly lower in the young adult females of lower SES. Hence, socio-economic class has a major determining role on an individual's health. The effect of hormonal fluctuations during the menstrual cycle also has a part to play in the variation of iron status measures, which has to be considered while measuring them in a female during her reproductive years, as it may alter the results depending on the phase of the menstrual cycle.

Further modifications are possible in our study which may further clarify our understanding. For instance we could possibly study the levels of various reproductive hormones and correlate with them. We could also take more comparable parameters like serum ferritin and transferrin receptor.

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