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Original Article

Biochemistry Section

Study of Serum Iron and Magnesium Levels in Pregnancy and its Relation to Dietary Intake

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ABSTRACT

Introduction: Iron is an essential micronutrient which is required to meet the growing demands of the mother and foetus during pregnancy. Iron supplementation during pregnancy is commonly practiced worldwide. Despite supplementation, the prevalence of Iron Deficiency Anaemia (IDA) in pregnancy is high. Severe anaemia in pregnancy is attributed to adverse pregnancy outcomes such as low birth weight, pre mature birth and increased maternal mortality. Magnesium deficiency during pregnancy has also been associated with eclampsia, pre-eclampsia, preterm births and low birth weight.

Aim: To assess the serum levels of iron and magnesium and its association with dietary patterns and demographic characteristics among rural pregnant women in Chengalpattu, Tamil Nadu, India.

Materials and Methods: This cross-sectional study was conducted among 54 pregnant women without any comorbid conditions. Serum iron levels and Total Iron Binding Capacity (TIBC) were estimated by Ferrozine method and magnesium levels were estimated by Calmagite method. Dietary intake of iron and magnesium was assessed by weekly food frequency questionnaire and their daily intake was calculated. Statistical analysis was performed by Statistical Package for the Social Sciences (SPSS) software.

Results: It was observed that there was a high prevalence of IDA in the rural pregnant women with mean haemoglobin values of 10.04±1.04 gm/dL. Mean serum iron levels were 95.74±37.50 µg/dL (35-145 µg/dL). Mean serum TIBC values were 171.78±90.78 µg/dL (250-450 µg/dL). Mean serum magnesium levels were 1.93±0.26 mg/dL (1.3-2.5 mg/dL) in the study population. About 24.1% of the participants had reduced dietary intake of iron lesser than 40 mg/day and magnesium intake was lesser than 300 mg/day in all the study participants. There was a statistically significant negative association between serum iron levels with maternal age and dietary intake in pregnant women (p-value<0.05). There was also a statistically significant negative association between serum magnesium levels with gestational age and parity (p-value<0.05).

Conclusion: Multiple Micronutrient (MMN) supplementations which include iron, folic acid, magnesium, zinc can be advocated in pregnancy for better outcomes and to reduce pregnancy associated morbidity and mortality. Awareness on the intake of fruits, vegetables, non-vegetarian food intake should be re-emphasised especially among rural pregnant women.

Keywords: Dietary patterns, Iron supplementation, Multiple micronutrient, Total iron binding capacity

INTRODUCTION

The iron requirements increase notably during second half of pregnancy due to increased red blood cell mass, transfer of iron to the growing foetus and development of the placental structures. The extent to which these requirements are met depends on the size of the prepregnant iron stores and dietary intake of iron during pregnancy. Iron is required for adequate immune functions during pregnancy which includes differentiation and proliferation of T lymphocytes and generation of reactive oxygen species by iron dependent enzymes needed for killing the pathogens. Pregnant women are susceptible to infections due to low levels of iron in the body. As a result, iron supplementation has become a common practice during pregnancy. An early haemodynamic change that occurs during pregnancy includes increase in plasma volume and raised 2,3-diphosphoglycerate concentrations. During the initial stages, erythropoeitic activity is decreased, red blood cell mass is reduced, reduction in the number of reticulocytes and increase in serum ferritin concentration. During the second trimester, iron needs begin to augment and keep on increasing throughout the pregnancy. Increase in oxygen consumption by both mother and foetus is linked with major haematologic changes [1]. Recommended dietary requirements of iron during pregnancy is 40 mg/day. Dietary sources of iron include jaggery, organ meats (liver, heart), leafy vegetables, pulses, cereals, apples, dry fruits and fish. All the indexes of IDA such as haemoglobin, transferrin saturation, ferritin concentrations are reduced during pregnancy. Transferrin receptor concentration and TIBC is increased during pregnancy [2]. In case of antenatal women, a dose of 60 mg of ferrous iron has to be supplemented starting from the second trimester of pregnancy. In case of IDA (Hb<11g/dL), 120 mg of ferrous iron can be supplemented [3].

Magnesium is required for the wellbeing of the foetus. Its deficiency during pregnancy has been associated with eclampsia, pre-eclampsia, preterm births, low birth weight, small for gestational age babies. Magnesium sulphate is used in the treatment of eclampsia in pregnancy. Less than 1% of the total body magnesium is found in plasma and red blood cells. Prevalence of magnesium deficiency is reported to be between 4.8-48% [4,5]. Recommended dietary allowance for magnesium is about 300 mg per day. Cereals, vegetables, nuts, fruits, milk and meat are good sources of magnesium [2]. Hypomagnesemia has been reported to affect parturition, postpartum uterine involution, impaired foetal growth and development. Hypomagnesemia during pregnancy decreases the magnesium levels in myometrium and low myometrial magnesium levels leads to preterm labour. Raising magnesium levels tends to relax uterine muscle and thus functions as a tocolytic agent in pregnancy [5]. Trials have shown that magnesium supplementation helps to reduce hypertension, preterm birth, abortions and intrauterine growth retardation (IUGR) of the foetus [6].

Despite iron and folic acid supplementation in pregnancy, most of the pregnant women in rural areas are prone to develop IDA. Cause can be attributed to non-compliance of iron supplementation, inadequate supplementation or insufficient dietary intake of heme sources of iron with better bioavailability. There are few studies done assessing serum magnesium levels during pregnancy and its relationship with dietary intake in India [7,8]. Hence, this study was conducted to assess the serum levels of iron, TIBC and magnesium levels in rural pregnant women belonging to south Indian population and its association with their dietary intake and demographic characteristics.

MATERIALS AND METHODS

This cross-sectional study was conducted on 54 pregnant women attending tertiary care hospital in rural area in Chengalpattu district, Tamil Nadu, India, from March-May 2020. Institutional Ethical Committee approval was obtained with IEC No. 2019/513. All the patients referred to the laboratory after obtaining informed consent were enrolled in the study. Inclusion criteria included women with singleton pregnancy in all trimester between age group of 20-30 years. Exclusion criteria includes subjects with severe anaemia (Hb<7g/dL), twin pregnancies, pre-eclampsia, eclampsia, antenatal bleeding, Diabetes mellitus, chronic hypertension, malignancies, infections, infestations, alcohol and drug abuse.

Serum sample was collected from all the study participants. Serum sample was centrifuged at 3000 rpm for 5 minutes and the serum was analysed for Iron, TIBC by Ferrozine method [9] and magnesium was estimated by Calmagite method [10] according to manufacturer's instructions provided by Tulip diagnostics, Goa. Patient's age, obstetric profile, socioeconomic was assessed by Udai Pareek classification [11]. Comorbidities were collected using a proforma and the average dietary intake of iron and magnesium was calculated using a validated food frequency questionnaire for a week which includes the type of food item, its frequency and quantity [12]. The nutrient content of the food item was calculated according to Food data central database, USDA [13]. The primary variable measured in the study was the prevalence of Iron and Magnesium deficiency in the rural pregnant women and the secondary variable assessed was the cause of deficiency including the dietary intake and demographic characteristics. Dependent variables in the study included the serum levels of Iron, TIBC, Magnesium in the study participants and the independent variables were dietary intake, maternal age, parity, gestational age, socioeconomic status and non-veg intake.

STATISTICAL ANALYSIS

Statistical analysis was performed by using SPSS software. Results were reported as Mean± Standard deviation for quantitative variables. Chi-square test was used to evaluate the significance of difference between the two groups. The p-value <0.05 was considered as a statistically significant difference.

RESULTS

[Table/Fig-1] shows the demographic characteristics of pregnant women with reference to maternal age, gestational age, parity, socioeconomic status and type of dietary intake. Majority of the women belonged to age group of 20-25 years (51.9%), gestational age of 27-37 weeks (46.3%), parity as 1 (75.9%), lower socioeconomic status (55.6%) and non-vegetarian diet (57.4%). [Table/Fig-2] shows the distribution of serum iron, TIBC and magnesium levels among the study participants. The mean serum iron levels were 95.74±37.50 μg/dL (35-145 μg/dL). Mean serum TIBC values were 171.78±90.78 μg/dL (250-450 μg/dL). Mean serum magnesium levels were 1.93±0.26 mg/dL (1.3-2.5 mg/dL).

[Table/Fig-3] shows the daily intake of iron, magnesium among the study participants. It was found that 24.1 (%) of the study participants had daily intake of iron lesser than 40 mg/day. All the study participants had their magnesium intake lesser than 300 mg/day. The serum levels of iron were decreased with increasing maternal age and vegetarian diet [Table/Fig-4] which were statistically significant (p-value<0.05).

No.	Variable	Frequency	Percentage
1	**Age (years)**		
	20-25	28	51.9
	25-30	22	40.7
	30-35	4	7.4
2	**Gestational age**		
	1-12 weeks	4	7.4
	13-26 weeks	23	42.6
	27-37 weeks	25	46.3
	≥ 38 weeks	2	3.7
3	**Parity**		
	0	4	7.4
	1	41	75.9
	2	9	16.7
4	**SES**		
	Low	30	55.6
	Lower middle	19	35.2
	Middle	5	9.3
5	**Type of diet**		
	Veg	23	42.6
	Non-veg	31	57.4

[Table/Fig-1]: Distribution of demographic characteristic among the study participants.
SES: Socioeconomic status

Sl. no	Analytes	Frequency	Percentage (%)	Mean±SD	Range
1	**Fe (μg/dL)**			95.74±37.50	38-216
	35-145	50	92.6		
	>145	4	7.4		
2	**TIBC (μg/dL)**			171.78±90.78	70-484
	<250	46	85.2		
	>250	8	14.8		
3	**Mg (mg/dL)**			1.93±0.26	1-2
	<1.3	4	7.4		
	1.3-2.5	50	92.6		

[Table/Fig-2]: Distribution of serum Iron, TIBC, Magnesium levels as against the reference range.

Sl no	Analytes	Frequency	Percentage	Mean±SD	Range
1	**Fe (mg/day)**			78.06±48.95	3-160
	<40	13	24.1		
	>40	41	75.9		
2	**Mg (mg/day)**			45.02±22.85	15-80
	<300	54	100		
	>300	0	-		

[Table/Fig-3]: Distribution of average daily dietary intake of Iron, Magnesium among the pregnant women against Recommended Dietary Allowance (RDA).

There was no statistically significant association between TIBC values and demographic characteristics as shown in [Table/Fig-5]. Serum magnesium levels decreases with advanced gestational age and multiparity [Table/Fig-6] which was statistically significant (p-value<0.05). The mean serum Haemoglobin levels were 10.04±1.04 gm/dL. Haemoglobin levels decrease with advanced gestational age, multiparity, vegetarian diet [Table/Fig-7] which was highly statistically significant (p-value<0.001).

DISCUSSION

The present study suggests that 7.4% of the study participants had decreased serum magnesium levels less than 1.3 mg/dL. Serum iron levels are within the reference range for all the study participants. Dietary intake of iron is less than 40 mg/day (which

Sl. No	Variable	Fe (35-145 μg/dL) (n=50)	Fe (>145 μg/dL) (n=4)	p-value*
1	Age (years)			0.04
	20-25	28 (56.0)	0	
	25-30	18 (36.0)	4 (100)	
	30-35	4 (8.0)	0	
2	Gestational age			0.76
	1-12 weeks	4 (8.0)	0	
	13-26 weeks	22 (44.0)	1 (25)	
	27-37 weeks	22 (44.0)	3 (75)	
	≥ 38 weeks	2 (4.0)	0	
3	Parity			0.68
	0	4 (8.0)	0	
	1	38 (76.0)	3 (75)	
	2	8 (16.0)	1 (25)	
4	SES			0.66
	Low	27 (54)	3 (75)	
	Lower middle	18 (35)	1 (25)	
	Middle	5 (10)	0	
5	Type of diet			0.03
	Veg	27 (54)	4 (100)	
	Non-veg	23 (46)	0	

[Table/Fig-4]: Association of serum iron with demographic characteristics of the study participants.
*Chi-square test is used to find the statistical association between variables; SES: Socioeconomic status; p<0.05 significant

Sl. no	Variable	TIBC (<250 μg/dL) (n= 46)	TIBC (>250μg/dL) (n=8)	p-value*
1	Age (years)			0.85
	20-25	24 (52.2)	4 (50)	
	25-30	18 (39.1)	4 (50)	
	30-35	4 (8.7)	0	
2	Gestational age			0.09
	1-12 weeks	4 (8.7)	0	
	13-26 weeks	22 (47.8)	1 (12.5)	
	27-37 weeks	18 (39.1)	7 (87.5)	
	≥ 38 weeks	2 (4.3)	0	
3	Parity			0.61
	0	4 (8.7)	0	
	1	34 (73.9)	7 (87.5)	
	2	8 (17.4)	1 (12.5)	
4	SES			0.52
	Low	24 (52.2)	6 (75)	
	Lower middle	17 (37)	2 (25)	
	Middle	5 (10.9)	0	
5	Type of diet			0.65
	Veg	27 (58.7)	4 (50)	
	Non-veg	19 (41.3)	4 (50)	

[Table/Fig-5]: Association of serum TIBC with demographic characteristic of the study participants.
*Chi-square test is used to find the statistical association between variables; SES: Socioeconomic status; p<0.05 significant

is the recommended dietary allowance, RDA of Iron) in 24.1% of the pregnant women whereas magnesium intake is less than 300 mg/day Recommended Dietary Allowance (RDA) in all the study participants. There was negative association between serum iron levels and maternal age and vegetarian intake (p-value <0.05). There was also negative association between serum magnesium, (p-value <0.05) Hb values (p-value<0.001) with gestational age and parity. The dietary pattern assessed using the food frequency questionnaire

Sl. no	Variable	(<1.3 mg/dL) (n=4)	(1.3-2.5 mg/dL) (n=50)	p-value*
1	Age (years)			0.17
	20-25	4 (100)	24 (48)	
	25-30	0	22 (44)	
	30-35	0	4 (8)	
2	Gestational age			0.04
	1-12 weeks	2 (50)	2 (4)	
	13-26 weeks	1 (25)	22 (44)	
	27-37 weeks	1 (25)	24 (48)	
	≥ 38 weeks	0	2 (4)	
3	Parity			0.03
	0	2 (50)	2 (4)	
	1	2 (50)	39 (78)	
	2	0	9 (18)	
4	SES			0.39
	Low	1 (25)	29 (58)	
	Lower middle	3 (75)	16 (32)	
	Middle	0	5 (10)	
5	Type of diet			0.30
	Veg	1 (25)	30 (60)	
	Non-veg	3 (75)	20 (40)	

[Table/Fig-6]: Association of serum magnesium with demographic characteristic of the study participants.
*Chi-square test is used to find the statistical association between variables; SES: Socioeconomic status; p<0.05 significant

S. no	Variable	Mean±SD	p-value*
1	Age (years)		0.54
	20-25	10.04±1.03	
	25-30	10.14±1.03	
	30-35	9.50±1.29	
2	Gestational age		<0.001
	1-12 weeks	8.00±0.00	
	13-26 weeks	9.87±0.81	
	27-37 weeks	10.48±0.91	
	≥ 38 weeks	10.50±0.70	
3	Parity		<0.001
	0	8.00±0.00	
	1	10.27±0.80	
	2	9.89±1.26	
4	SES		0.27
	Low	10.23±1.00	
	Lower middle	9.74±1.04	
	Middle	10.00±1.22	
5	Type of diet		<0.001
	Veg	10.52±0.62	
	Non-veg	9.39±1.15	

[Table/Fig-7]: Average haemoglobin levels across demographic characteristics.
*Chi-square test is used to find the statistical association between variables; SES: Socioeconomic status; p<0.05 significant

consisted mainly of cereal and plant based diet and less consumption of nuts, fruits, vegetables, dairy products and non-veg.

In a study done by Pathak P et al., there was a prevalence of 42.6% of pregnant women with magnesium deficiency in the third trimester. Magnesium levels were decreased with increasing parity and deficiency during the third trimester is attributed to haemodilution [7]. Kapil U et al., documented magnesium deficiency of 4.6% in a study done in urban slum dwellers in Delhi, India [8]. In present study, four of the study participants which accounts to 7.4% of the pregnant women belonging to first, second and third trimester have magnesium deficiency with serum levels less than 1.3 mg/dL. Al Nasir S et al., suggests 27.08% of the women of childbearing age were iron deficient as shown by serum ferritin and transferrin saturation. Iron supplementation has significant effects on the TIBC, ferritin and haemoglobin concentrations [14]. In the present study, all the study participants had mean serum iron levels of 95.74±37.50 μg/dL which is within the reference range but mean haemoglobin levels were less than 12 g/dL in all the study participants.

The prevalence of IDA is high throughout the world despite the measures taken to combat it. Various factors such as socioeconomic status, education and family size affect the iron levels. In a study done on 162 adolescent females in India, 104 (64.2%) had mild, 59 (36.2%) had moderate, and only 1 participant (0.6%) had severe anaemia [15]. Study done in Saudi Arabia suggests iron deficiency ranging from 30-56% [16]. Iron supplements during pregnancy helps to combat IDA. Kocyłowski R et al., in their study suggested that magnesium intake was only 75% of the RDA. They concluded that the use of supplements increases the levels of micronutrients. However, in the case of magnesium, calcium and vitamin D, the recommended intake levels were not achieved. The magnesium levels in the women's hair are affected by maternal age and gestational age [17]. Zarean E and Tarjan A showed in their study that IUGR, pre-eclampsia, low birth weight were considerably reduced in oral magnesium supplement groups [18]. Roman A et al., concluded that pregnancy induced IUGR was reduced by 64% due to oral magnesium supplementation in pregnancy [19]. It was noted in the observational study conducted by Shaikh K et al., many pregnancy outcomes such as toxaemia of pregnancy, IUGR, preterm birth were more pronounced in groups with hypomagnesemia than the normal groups [20]. Doyle W et al., concluded that magnesium supplementation towards the end of first trimester of pregnancy was associated with optimum birth weight, length and head circumference [21].

The results of this study conclude that there was high prevalence of IDA in the rural pregnant women in the south Indian population with mean haemoglobin values of 10.04±1.04 gm/dL (<12 gm/dL). Cause of iron deficiency can be attributed to deficient consumption of heme sources of iron such as oysters, liver, organ meats, beef, poultry which has increased bioavailability. It can also be due to non adherence to iron supplementation or inadequate supplementation of iron in rural pregnant women. Prevalence of anaemia increases with gestational age due to haemodilution and parity due to multiple childbirths and closely spaced pregnancies. Magnesium deficiency can be caused by inadequate dietary intake of fruits, vegetables and nuts. MMN supplementation has to be strongly emphasised in pregnancy to improve the maternal and foetal outcomes.

Strength of the study includes assessment of the dietary patterns of the rural pregnant women of lower socioeconomic status using validated food frequency questionnaire.

Limitation(s)

Smaller sample size of the study population. Further studies evaluating other micronutrients such as Iodine, Selenium, Zinc, Copper can be recommended.

CONCLUSION(S)

Micronutrient deficiencies during pregnancy have adverse outcomes on both the mother and the foetus. MMN supplementation has to be formulated for all the pregnant mothers and not restricted to iron, calcium and folic acid alone. Dietary advice regarding the consumption of milk, poultry, nuts, fruits, vegetables, organ meat etc., can be promulgated among the pregnant women in the rural areas and adherence to it can be evaluated by using validated food frequency questionnaire in the OPD. These preventive measures have to be vigorously followed to combat micronutrient deficiencies in India.

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