Prevalence of Multiple Micronutrient Deficiencies Amongst Pregnant Women in a Rural Area of Haryana

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Abstract. Deficiencies of micronutrients (zinc, iron, folic acid and iodine) during pregnancy are known causes of Low Birth Weight (LBW). Studies have documented status of one or two micronutrients amongst pregnant women (PW). However, no attempt has been made to concurrently assess the prevalence of multiple micronutrient deficiencies and the factors associated with them amongst PW. ***Objective:*** The present study was undertaken to assess the prevalence of multiple micronutrient deficiencies amongst PW in a rural area. ***Methods:*** A community based cross sectional survey was conducted in six villages of a rural area of district Faridabad in Haryana state, India during November 2000 and October 2001. All PW aged 18 years or more, with pregnancy duration of more than 28 weeks were enrolled. Data were collected on socio-economic status and other demographic parameters. Serum zinc, copper and magnesium levels were estimated by utilizing the Atomic absorption spectrophotometry (AAS); serum ferritin and folate was estimated by Enzyme Linked Immuno Sorbent Assay (ELISA) method and the Radio-Immuno Assay (RIA) method, respectively and serum thyroid stimulating hormone (TSH) level was estimated by the Abbot AxSYM System. Serum zinc, copper, magnesium, ferritin, and folate levels less than 70.0 μg/dl, 80.0 μg/dl, 1.80 mg/dl, 15 ng/ml, and 3 ng/ml, respectively were considered as indicative of deficiency for respective micronutrients. The TSH levels of 4.670 and more indicated iodine deficiency status. Dietary intake of micronutrients was assessed utilizing 1-day 24-hour dietary recall methodology. Food consumption pattern was assessed utilizing the food frequency questionnaire methodology. ***Results:*** Nearly 73.5, 2.7, 43.6, 73.4, 26.3, and 6.4 percent PW were deficient in zinc, copper, magnesium, iron, folic acid and iodine, respectively. The highest concurrent prevalence of two, three, four and five micronutrient deficiency was of zinc and iron (54.9%); zinc, magnesium and iron (25.6%); zinc, magnesium, iron and folic acid (9.3%) and zinc, magnesium, iron, folic acid and iodine (0.8%), respectively. No pregnant woman was found to have concomitant deficiencies of all the six micronutrients. Dietary intake data revealed an inadequate nutrient intake. Over 19% PW were consuming less than 50% of the recommended calories. Similarly, 99, 86.2, 75.4, 23.6, 3.9 percent of the PW were consuming less than 50% of the recommended folic acid, zinc, iron, copper, and magnesium. The consumption of food groups rich in micronutrients (pulses, vegetables, fruits, nuts and oil seeds, animal foods) was infrequent. Univariate and Multivariate logistic regression analysis revealed that low dietary intake of nutrients, low frequency of consumption of food groups rich in micronutrients and increased reproductive cycles with short interpregnancy intervals were important factors leading to micronutrient deficiencies. ***Conclusion:*** There was a high prevalence of micronutrient deficiencies amongst the PW of the area, possibly due to the poor dietary intake of food and low frequency of consumption of food groups rich in micronutrients. The concurrent prevalence of two, three, four and five micronutrient deficiencies were common. **[Indian J Pediatr 2004; 71 (11) : 1007-1014]**
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Key words : *Multiple micronutrient deficiencies; Zinc deficiency; Magnesium deficiency; Copper deficiency; Iron deficiency; Folate deficiency; Iodine deficiency*

Pregnancy is a period of increased metabolic demands mainly due to changes in the woman's physiology and the requirements of the growing fetus.[1] During this period, deficiency of micronutrients has detrimental effect on the health of both pregnant women (PW) and the growing fetus. Deficiencies of zinc, copper, magnesium, iron, folic acid, and iodine have been associated with pregnancy wastage, congenital anomalies, pregnancy induced hypertension, premature rupture of membranes, placental abruption, premature deliveries, still births and a high incidence of low birth weight babies.[2-8]

Various studies have documented the status of either one or two micronutrients amongst PW. However, no attempt has been made to concurrently assess the prevalence of multiple micronutrient deficiencies and the associated factors. The present study was conducted to assess *(i)* the status of zinc, copper, magnesium, iron, folic acid and iodine individually and in combination amongst the PW, *(ii)* factors associated with the micronutrient

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deficiencies, and *(iii)* dietary intake of micronutrients amongst the PW in a rural block of district Faridabad, in Haryana state, India.

MATERIALS AND METHODS

A community based cross sectional survey was conducted in six rural villages of district Faridabad in Haryana State, India between November 2000 and October 2001. All PW of the study area were enrolled utilizing the following inclusion criteria *(i)* the PW should be 18 years or more in age, *(ii)* pregnancy duration should be 28 weeks or more, *(iii)* the women should not be suffering from any chronic diseases affecting the dietary intake pattern, and *(iv)* the women should not be suffering from any acute morbidity condition on the day of survey. The approval of the Ethical Committee of All India Institute of Medical Sciences, New Delhi, India, was undertaken. Objectives of the study were explained to all women and informed consent was obtained.

A pre-tested semi structured open-ended questionnaire was administered to each subject to elicit the required information by undertaking the domiciliary visits. Data were collected on the parameters of identification, socio economic status, obstetric history, and dietary intake. The dietary intake of the micronutrients by the women was assessed utilizing a one-day 24 hr dietary recall methodology.[9] Recommended Dietary Allowances (RDA) suggested by the ICMR[10] were utilized to assess the adequacy of nutrient intake of the women. The food consumption pattern of various food groups was assessed utilizing the food frequency questionnaire methodology.[9]

Venous blood samples were collected for the assessment of status of zinc, copper, magnesium, iron, folic acid, and iodine. Serum levels of zinc, copper, and magnesium were assessed by the standard atomic absorption spectrophotometry (11) method. Serum zinc, copper, and magnesium levels less than 70.0 mg/dl (12), 80.0 mg/dl (11), and 1.8 mg/dl (11), respectively were considered as indicative of deficiency for respective micronutrients. For iron status, serum ferritin levels were assessed by the standard ELISA method (13) using Microwell Enzyme Immunoassay Human Ferritin Quantitative EIA Kit (BIOPLUS, INC). Serum ferritin levels less than 15 ng/ml were considered as indicative of iron deficiency (14). Status of folic acid was assessed by estimating the serum folate levels by the standard RIA method (15) using Simul TRAC-SNB Radioassay Kit. Serum folate levels less than 3 ng/ml were considered as indicative of folic acid deficiency. Iodine status was assessed by estimating the levels of thyroid-stimulating hormone (TSH) by the Abbot AxSYM System (16). TSH levels of 4.670 or more were considered as indicative of iodine deficiency. All the estimations were undertaken in triplicates and mean of the three values were taken as the micronutrient level of the serum sample. Serum samples of known concentrations of zinc, copper, magnesium, ferritin, folic acid and TSH were estimated with each batch of assay as an internal quality control. The estimation was repeated for the batch of assay in which the control sample values were over or under estimated.

Data were subjected to statistical tests utilizing SSPS-7.5 Statistical Software. Univariate and multivariate logistic regression analysis was used to calculate Relative Risk (RR) and CI at 95% for all the independent variables of the micronutrient studied. Multivariate logistic regression was applied by "Enter Method" to identify the significant factors associated with the specific micronutrient deficiency.

RESULTS

A total of 283 PW (mean age: 22.9 years) were enrolled for the study. Data revealed that 31.8% PW were illiterate and majority (81.9%) belonged to the lower middle and middle socio-economic status.[17]

Nearly 51% of the PW had pregnancy duration of 28 – 32 weeks. Almost 39.2% PW were nulliparous. Forty one percent PW had inter-pregnancy interval of less than 30 months.

Nutrient intake data of PW revealed deficit intake of calories, protein, zinc, copper, iron and folic acid. Only mean dietary intake of magnesium was higher than the RDA. Calorie intake was less than 50% of RDA in 19.3% of the PW indicating a low food intake. Similarly, 99, 86.2, 75.4, 23.6, and 3.9 percent PW were consuming less than 50% of the RDA for folic acid, zinc, iron, copper, and magnesium, respectively (Table 1).

TABLE 1. **Mean Dietary Intake of the Study Subjects**

Nutrient	RDA	Mean Intake	% Intake of RDA	Pregnant women consuming	
				< 50% RDA	≥ 50% RDA
Calories (kcal)	2175	1527	72.2	19.3	80.7
Zinc (mg)	15	5.4	36	86.2	13.8
Copper (mg)	2	1.8	90	23.6	76.4
Magnesium (mg)	300	336	112.3	3.9	96.1
Iron (mg)	38	15	39.5	75.4	24.6
Folic Acid (μg)	400	51.4	12.9	99.0	1.0

The food consumption pattern revealed that 70% PW were vegetarians. Twenty five percent PW consumed pulses only 1–2 days/month. Other vegetables and fruits were consumed only by 24 and 13.8 percent of PW, respectively 4-7 days/week. The consumption of green leafy vegetables and nuts and oil seeds was seasonal (consumed only in winters). Only 24 and 16.6 percent PW consumed green leafy vegetables and nuts and oil seeds respectively, 4-7 days/week in the winter season. Food items rich in micronutrients (pulses, vegetables, fruits, nuts and oilseeds and animal foods) were generally consumed less frequently.

Biochemical estimations revealed that 73.5, 2.7, 43.6, 73.5, 26.3 and 6.4 percent PW had zinc, copper, magnesium, iron, folic acid, and iodine deficiency, respectively (Table 2).

Data on concomitant prevalence of two micronutrient deficiencies revealed that the deficiency of zinc and iron was highest (54.9%), followed by magnesium and iron (33.9%), zinc and magnesium (33.1%), iron and folic acid (21.4%) and zinc and folic acid (18.6%). Concomitant prevalence of other micronutrient deficiencies were in the range of 1.6 – 13.9% of the PW. Data on concomitant prevalence of three micronutrient deficiencies revealed that the deficiency of zinc, magnesium and iron was highest (25.6%), followed by zinc, iron and folic acid (16.0%). Concomitant deficiencies of three other micronutrients were in the range of 1.2 – 10.1% of the PW. Concomitant prevalence of four micronutrient deficiencies was highest for zinc, magnesium, iron and folic acid (9.3%), whereas concomitant deficiencies of other four micronutrients were in the range of 0.8 – 1.9% only. Concomitant prevalence of five micronutrient deficiencies was highest for zinc, magnesium, iron, folic acid and iodine (0.8%). No PW had concomitant deficiency of all the six micronutrients (Table 3).

UNIVARIATE AND MULTIVARIATE LOGISTIC REGRESSION ANALYSIS

Zinc

The univariate and multivariate analysis revealed that no variable was significantly associated with the zinc deficiency. However a decreasing trend in serum zinc levels was observed with low dietary intake of calories. The PW with calorie intake less than 50% of the RDA had lower serum zinc levels compared to those with a higher calorie intake (59.84±13.5 vs 63.5±15.1 μg/dl). There was a decrease in serum zinc levels also with decrease in the frequency of consumption of pulses and nuts and oilseeds.

Copper

Only 7 PW were deficient in copper levels .The univariate and multivariate analysis revealed that no variable was significantly associated with the copper deficiency. However, a significant increase in the serum copper levels was found with the increase in pregnancy duration (p = 0.01).

Table 3. Concomitant Prevalence of Micronutrient Deficiencies Amongst the Pregnant Women

Concomitant Prevalence	Combination	n	(%)
Two Micronutrient Deficiencies	Zn + Fe	141	(54.9)
	Mg + Fe	88	(33.9)
	Zn + Mg	85	(33.1)
	Fe + FA	57	(21.4)
	Zn + FA	48	(18.6)
	Others	4 - 36	(1.6 - 13.9)
Three Micronutrient Deficiencies	Zn + Mg + Fe	68	(25.6)
	Zn + Fe + FA	41	(16.0)
	Mg + Fe + FA	31	(12.2)
	Zn + Mg + FA	26	(10.1)
	Others	3 - 8	(1.2 - 3.1)
Four Micronutrient Deficiencies	Zn + Mg + Fe + FA	24	(9.3)
	Others	3 - 5	(1.2 - 1.9)
Five Micronutrient Deficiencies	Zn + Mg + Fe + FA + I	2	(0.8)
	Others	0	(0.0)

Zn = Zinc, Cu = Copper, Mg = Magnesium, Fe = Iron, FA = Folic Acid, I =Iodine

Magnesium

The univariate analysis revealed that parity and inter pregnancy interval were significantly associated with the magnesium deficiency (Table 4). The PW with a parity of 2 or more and those with an inter pregnancy interval of less than 30 months were at a 2.59 (95% CI: 1.41-4.47; p=0.002) and 2.11 (95% CI: 1.2-3.68; p=0.008) times higher risk of magnesium deficiency, respectively, compared to those who had their first pregnancy. Also, there was a decreasing trend in serum magnesium levels with the low dietary intake of magnesium (<50% of RDA: 1.73 ± 0.246 vs > 50% of RDA: 1.86 ± 0.323 mg/dl) and low frequency of consumption of fruits.

The multivariate analysis also revealed that parity was significantly associated with the magnesium deficiency (Table 5). The PW with parity of two or more were at a

Table 2. Distribution of Pregnant Women According to their Micronutrient Status

Micronutrient	Cut-off	Deficient	Non-Deficient
Zinc	< 70.0 μg/dl	189 (73.5)	68 (26.5)
Mean ± SD		53.8 ± 10.4 μg/dl	81.3 ± 13.6 μg/dl
Copper	< 80.0 μg/dl	7 (2.7)	248 (97.3)
Mean ± SD		55.6 ± 14.8 μg/dl	196.8 ± 57.1 μg/dl
Magnesium	< 1.8 mg/dl	113 (43.6)	146 (56.4)
Mean ± SD		1510.8 ± 218 μg/dl	2.199 ± 0.52 μg/dl
Iron	< 15 ng/ml	196 (73.4)	71 (26.6)
Mean ± SD		6.7 ± 3.2 ng/ml	42.3 ± 41.5 ng/ml
Folic Acid	< 3.0 ng/ml	70 (26.3)	196 (73.7)
Mean ± SD		2.1 ± 0.6 ng/ml	7.9 ± 5.3 ng/ml
Iodine	> 4.670 mIU/L	17 (6.4)	248 (93.6)
Mean ± SD		6.9 ± 3.3 mIU/L	2.2 ± 0.9 mIU/L

(Figures in parenthesis denote percentages)

2.48 (95% CI: 1.9-5.2; p=0.00) times higher risk of magnesium deficiency compared with the PW with nil parity. No other variable was found to be associated with magnesium deficiency.

Iron

The univariate analysis revealed that no variable was significantly associated with iron deficiency. However, PW with nil parity had a higher serum ferritin level (18.4 ng/ml) compared to those with parity 1 (17.0 ng/ml) or 2 or more (12.6 ng/ml). Also, PW who consumed more than 10 IFA tablets in the past 15 days showed a higher serum ferritin level compared to those who consumed less than 10 tablets (16.4 vs 15.8 ng/ml). Further, the PW with dietary iron intake of less than 50% of the RDA showed a lower serum ferritin level compared to those with a higher iron intake (17.5 vs 21.3 ng/ml). Also, there was a decreasing trend in serum ferritin levels with decrease in frequency of consumption of green leafy vegetables and nuts and oilseeds.

The multivariate analysis revealed that parity was associated with iron deficiency (Table 5). The PW with parity 1 or 2 or more were at a 2.54 (95% CI: 1.06-6.05; p=0.03) and 2.34 (95% CI: 1.04-5.25; p=0.03) times, respectively higher risk of iron deficiency compared with nulliparous PW. No other variable was found to be associated with iron deficiency.

Folic Acid

The univariate analysis revealed that socio-economic status, education, parity, and inter-pregnancy interval were significantly associated with folic acid deficiency (Table 4). The PW belonging to lower or lower middle socio economic status were at a 2.40 (95% CI: 1.37-4.21; p = 0.002) times higher risk of folic acid deficiency compared to PW belonging to higher socio economic status (middle / upper-middle / upper class). The illiterate PW were at a 2.58 (95% CI: 1.09-6.12; p = 0.03) times higher risk of folic acid deficiency compared to the PW who were matriculate or had higher education. Similarly, PW with a parity of 2 or more were at a 3.51 (95% CI: 1.76-7.01; p=0.0004) times higher risk of folic acid deficiency compared to the women with 0 parity. Inter pregnancy interval of less than 30 months was associated with a 2.1(95% CI: 1.08-4.08; p=0.02) times higher risk of folic acid deficiency compared to women who had their first pregnancy. PW with calorie consumption of less than 50% of the RDA had a lower serum folate level compared to those with higher calorie intake (5.1 ± 4.8 vs 6.7 ± 5.6 ng/ml) and there was a decrease in serum folate levels with decrease in frequency of consumption of pulses and nuts and oilseeds.

The multivariate analysis revealed that socio economic status and parity were significantly associated with folic acid deficiency (Table 5). The PW of poor socio economic status were at 2.25 (95% CI: 1.12-4.54; p=0.02) times higher risk of folic acid deficiency. Similarly, PW with a parity of 2 or more had 2.32 (95% CI: 1.009-5.32; p=0.04) times higher risk of folic acid deficiency compared with nulliparous women. No other variable was found to be associated with folic acid deficiency.

TABLE 4. Univariate Analysis for Micronutrients Magnesium, Folic Acid and Iodine

Variable	Categories	Definition	β	Standard Error	Relative Risk	Confidence Interval at 95%	
						Lower	Upper
Magnesium							
Parity	0	0					
	1	1	0.47	0.31	1.6	0.86	2.96
	2	2 or more	0.95	0.3	2.59	1.41	4.47
Inter pregnancy	0	0					
Interval	1	30 months or more	0.21	0.35	1.23	0.61	2.49
	2	less than 30 months	0.74	0.28	2.11	1.2	3.68
Folic Acid							
Socio Economic	0	upper/upper middle/middle					
Status	1	lower/lower middle	0.87	0.28	2.4	1.37	4.21
Education	0	high school or more					
	1	primary/middle	0.67	0.43	1.96	0.83	4.64
	2	Illiterate	0.95	0.44	2.58	1.09	6.12
Parity	0	0					
	1	1	0.67	0.37	1.96	0.94	4.08
	2	2 or more	1.25	0.35	3.51	1.76	7.01
Inter pregnancy	0	0					
Interval	1	30 months or more	0.16	0.3	1.21	0.51	6.84
	2	less than 30 months	0.74	0.33	2.1	1.08	4.08
Iodine							
Pregnancy	0	28 – 32 weeks					
Duration	1	32 – 36 weeks	0.62	0.62	1.87	0.55	6.33
	2	36 weeks or more	1.39	0.63	4.04	1.17	13.97

TABLE 5. Multivariate analysis for micronutrients Magnesium, Iron, and Folic Acid

Variable	Categories	Definition	β	Standard Error	Relative Risk	Confidence Interval at 95%	
						Lower	Upper
Magnesium							
Parity	0	0					
	1	1	0.44	0.41	1.55	0.69	3.45
	2	2 and more	0.91	0.37	2.48	1.19	5.2
Iron							
Parity	0	0					
	1	1	0.93	0.44	2.54	1.06	6.05
	2	2 and more	0.85	0.41	2.34	1.04	5.25
Folic Acid							
Socio-Economic	0	upper/upper middle/middle					
Status	1	lower/lower middle	0.81	0.35	2.25	1.12	4.45
Parity	0	0					
	1	1	0.67	0.45	1.97	0.8	4.82
	2	2 and more	0.84	0.42	2.32	1.009	5.32

Iodine

The univariate analysis revealed that pregnancy duration was significantly associated with iodine deficiency (Table 4). The PW with pregnancy duration of more than 36 weeks were at a 4.04 (95% CI: 1.17-13.97; p=0.02) times higher risk of iodine deficiency compared to PW with duration 28–32 weeks. The multivariate analysis revealed that no variable was significantly associated with iodine deficiency.

DISCUSSION

Zinc

In the present study, 73.5% of the PW had zinc deficiency as per serum zinc levels (<70.0 μg/dl). However, a study conducted in urban slums of Delhi reported a lower zinc prevalence of 55.5%, possibly because of the lower cut-off (<60.0 μg/dl) of serum zinc levels used.[18] Another study reported zinc deficiency amongst 22% PW of III trimester with a cut-off level of 50.0 μg/dl.[2]

The univariate analysis revealed that no variable was significantly associated with zinc deficiency. However, a decreasing trend was observed in serum zinc levels with decrease in calorie intake. The multivariate logistic regression analysis also revealed that no variable was associated with zinc deficiency possibly due to the fact that majority of the PW had deficient serum zinc levels. Also, the cut-off utilized in our study was higher (70.0 μg/dl) than in other studies.

The higher prevalence of zinc deficiency found in the present study was possibly due to the inadequate zinc consumption. Almost 19.3% PW were consuming less than 50% of the calories, recommended for their physiological status. The present study was undertaken in a community subsisting on a cereal based diet. More than 90% of the calories consumed were received from cereals (wheat). The high presence of phytates and dietary fiber and thus a high phytate: zinc molar ratios are known to cause poor absorption of zinc.[19] This could be another contributing factor for high prevalence of zinc deficiency in our study population.

Poor pre-pregnancy nutritional status and low serum zinc levels of the women and hemodilution during pregnancy could also be a contributing factor for lower zinc levels in the present study population[2, 20 - 23]

Copper

Earlier studies have documented only the mean serum copper levels but so far no study has documented the prevalence of copper deficiency. In the present study, 2.7% of the PW had deficient serum copper levels (<80.0 μg/dl), possible because during pregnancy the copper excretion is low as it binds with ceruloplasmin which is secreted in the last trimester of pregnancy.

The univariate as well as multivariate logistic regression analysis revealed that no variable was significantly associated with copper deficiency. This may possibly be due to the fact that only 7 PW were deficient in copper. However, there was a significant increase in serum copper levels with increase in pregnancy duration. Other studies have documented similar findings. Studies have reported that the increase in serum copper during pregnancy is mainly in bound form due to increase in the carrier proteins, ceruloplasmin; in response to stimulation by elevated levels of maternal estrogens.[24-26]

Magnesium

In the present study, 43.6 % of the PW were deficient in magnesium (serum magnesium levels <1.80 mg/dl). A study conducted in urban slums of Delhi reported a lower magnesium deficiency prevalence of 4.6 % possibly because of lower serum magnesium cut-off (<1.50 mg/dl) level used.[18] Another study documented a higher prevalence of magnesium deficiency (51.5%) amongst PW (pregnancy duration 25 weeks and more).[27] This could be due to the difference in the pregnancy duration of the women enrolled and the method utilized for the estimation of serum magnesium level.

The univariate analysis of the data revealed that parity and inter pregnancy interval were significantly associated with magnesium deficiency. The multivariate logistic regression analysis revealed that parity was associated with magnesium deficiency.

The high prevalence of magnesium deficiency (43.6%) was possibly due to the high parity and lower inter-pregnancy interval. There is an active transport of magnesium across the placenta into the fetus[28] due to which there is a progressive decrease in the circulating serum magnesium levels during pregnancy. Low dietary intake coupled with increase demand for growth and accelerated metabolism during pregnancy could be other contributing factors.[29] The hemodilution during the last trimester of pregnancy could also be a contributing factor.[30-32]

Iron

In the present study, 73.4% of the PW were deficient in iron (serum ferritin levels <15 ng/ml). A recent study from India reported a prevalence of 22 % of iron deficiency utilizing similar cut off levels.[33] Another study by Abel *et al* reported a iron deficiency prevalence of 48.4% amongst PW.[34] These studies reported a lower iron deficiency prevalence compared to our study possibly due to the variation in the place of study and exposure of subjects to different factors leading to deficient iron status like low dietary intake, infections and morbid conditions, infestation etc. The present study was undertaken in a rural area and the PW had a lower dietary iron intake compared to the other two studies. Moreover. 75% of the PW in our study were consuming iron less than 50% of the RDA (38 mg).

The univariate analysis of the data revealed that no variable was significantly associated with iron deficiency. The multivariate analysis revealed that parity was significantly associated with iron deficiency. Studies have documented that frequent cycles of reproduction leads to a greater risk of iron deficiency amongst the PW.[41-43]

The high prevalence of iron deficiency amongst PW (73.4%) found in the present study was possibly due to the inadequate food consumption by the PW. Nearly 19.3% of the PW were consuming less than 50% of the calories, recommended for their physiological status. Similarly 75.4% of the PW were consuming iron less than 50% of their RDA.

The lower cut-off utilized by earlier studies and pre-conceptional iron status could be major factors for lower prevalence of iron deficiency compared to our study. Hemodilution could be another reason for the high prevalence of iron deficiency amongst PW in the present study.[44]

Folic Acid

In the present study, 26.3 % of the PW were deficient in folic acid (serum folate levels < 3.0 ng/ml). Earlier studies from India have reported folic acid deficiency in the range of 21–63.5%.[45-49] Studies from other countries reported prevalence of folic acid deficiency in the range of 1.9–60.9%.[50-53] A wide variation in the folic acid deficiency prevalence in different studies may be due to the different cut-off levels utilized to define folic acid deficiency. Pre-conceptional nutritional status could be another possible reason for the variation in the prevalence of folic acid deficiency.

The univariate analysis revealed that socio-economic status, education, parity, and inter pregnancy interval were significantly associated with folic acid deficiency. An earlier study reported a decrease in serum folate levels with poor educational status,[54] whereas another study reported an association of parity and folic acid deficiency.[55] On the contrary, some other studies have reported no association between parity and folic acid deficiency.[52, 53]

The multivariate logistic regression analysis revealed that socio economic status and parity were associated with folic acid deficiency. Socio-economic status influences the purchasing power of food and thereby adequacy of folic acid intake. The repeated pregnancies and high parity leads to depletion of maternal nutritional resources in undernourished women.

The high prevalence of folic acid deficiency amongst PW (26.3%) found in the present study was possibly due to the inadequate food consumption by the PW also. Almost 20 and 99% of the PW were consuming less than 50% of the RDA for calories and folic acid, respectively. The pre-conceptional serum folate levels and hemodilution during last trimester could be other possible reasons for folic acid deficiency.[56]

Iodine

In present study 6.4% PW had elevated TSH levels (TSH > 4.699mIU/L). No study from India has reported iodine deficiency amongst PW utilizing elevated TSH as an indicator. Study from Bangladesh reported elevated TSH levels in 19% of PW,[57] which was higher than our findings. The difference in dietary intake of iodine in the subjects of the two studies could be the possible reason of variation in the prevalence of iodine deficiency.

The univariate analysis carried out amongst PW revealed that gestational age was significantly associated with iodine deficiency as indicated by elevated TSH levels. A gradual increase in serum TSH levels has been documented in iodine deficient mothers during pregnancy possibly due to the increased fetal needs for iodine.[58, 59] No variable was found to be significantly associated in the multivariate analysis amongst PW.

The prevalence of elevated TSH levels amongst PW was 6.4%. This could be possibly due to the low intake of iodine by the women. Thirty-six of PW were consuming salt with less than 5 ppm of iodine.

Concomitant Prevalence of Multiple Micronutrient Deficiencies

Concomitant prevalence of zinc and iron deficiency was highest amongst the PW (54.9%). It is well known that a low zinc and iron content of a diet is as common as its low bioavailability in the diets consumed in developing countries. Also, a high phytate content in the diet and low intake of animal/flesh foods results in poor bioavailability of zinc and iron. On an average, the PW were consuming only 36 and 39.5 percent of the RDA for zinc and iron, respectively. Moreover, almost 19.3% of them were consuming calories less than 50% of the RDA for their physiological status, indicating an inadequate food intake. A low intake of zinc and iron as well as poor food intake (as indicated by their calorie intake) could be the possible reason for a high concomitant prevalence of zinc and iron deficiency amongst the PW.

The PW in the present study were subsisting on a cereal-based (wheat) diet, which is known to be high in phytate content. Also, 70% of the PW were vegetarians, indicating a poor intake of animal foods (enhancers of zinc and iron absorption). A high dietary intake of phytate coupled with a low intake of animal foods could be another possible reason for the high concomitant prevalence of zinc and iron deficiency.

CONCLUSION

The findings of the present study revealed that there was a poor dietary intake of micronutrients by the PW and a high prevalence of micronutrient deficiencies (zinc, magnesium, iron, and folic acid) individually as well as concomitantly. There is a need to undertake multicentric studies in various parts of the country to substantiate the data obtained in the present study so that intervention measure required if any can be initiated.

Acknowledgement

We duly acknowledge the financial support provided by the Director General, Indian Council of Medical Research, New Delhi, India for the present study. The infrastructure facilities provided by the Director, All India Institute of Medical Sciences, New Delhi are also acknowledged.

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