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VITAMIN A AND NUTRITIONAL STATUS OF TEA ESTATE WORKERS DURING PREGNANCY

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SUMMARY. The vitamin A and nutritional status of 118 women workers living in three large estates belonging to the Sri Lanka State Plantations Corporation in Kalutara, Ratnapura and Matale regions were studied in early stages of pregnancy and followed up in late pregnancy.

They had a poor nutritional status at the onset of pregnancy. The mean body mass index (BMI) in early pregnancy was only 19.4±1.8 kg/m^2 and 27.9% had BMI values less than 18.5 kg/m^2, the value below which chronic energy deficiency is likely to exist in adults. Their mean rate of weight gain during pregnancy was 0.27±0.12 kg per week and 32.2% of the subjects had rates of weight gain less than 0.20 kg per week.

Their mean haemoglobin levels in early pregnancy was 9.73±1.72 g/dl and 25.0% of the women studied were severely anaemic (haemoglobin less than 8g/dl). The mean birth weight of infants born to mothers with low initial haemoglobin levels (<9.7 g/dl) was significantly lower ($p<0.01$) than that of infants born to mothers with higher haemoglobin levels. The percentage of severely anaemic mothers increased to 50.6% in late pregnancy.

A high incidence of early ocular manifestations of vitaimin A deficiency was also seen in these subjects. The percentage of subjects with low serum vitamin A levels (less than 20μg/dl) increased from 10.8% in early pregnancy to 29.6% in late pregnancy. Subjects in the Ratnapura and Matale regions had low retinol-binding protein levels in early pregnancy which decreased further in late pregnancy, indicating that vitamin A and energy-protein deficiencies coexist.

Thus multiple nutrient deficiencies affect pregnant estate workers and may account at least in part for the high incidence of low birth weight (29.5%) noted in the study population.

Key words: Pregnancy, Haemoglobin, Vitamin A Status

INTRODUCTION

Malnutrition is common among estate workers, specially females, and higher infant and maternal mortality rates have been recorded in the estate sector than in other sectors (1). Several intervention measures adopted in the recent past have resulted in a marked decrease in infant and maternal mortality rates (2).

The information available on the nutritional status, prevalence of anaemia and vitamin A deficiency, among pregnant estate workers in Sri Lanka is very limited. Maternal anaemia affects the outcome of pregnancy (3). A satisfactory vitamin A status in the mother is required for normal foetal development (4), and to ensure that the newborn has adequate reserves of the vitamin to meet the requirements for growth, development and resistance to infection.

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The aims of the present investigation were:

(1) To determine the nutritional status of the estate worker during pregnancy and its effect on the outcome of pregnancy.

(2) To determine whether vitamin A deficiency is a problem among these women.

(3) To suggest suitable intervention measures to improve their vitamin A and nutritional status.

POPULATION STUDIED

A random sample of 118 female estate workers (tea pluckers) in the age group 15—45 years, livng in the largest estates belonging to Sri Lanka State Plantations Corporation in Kalutara, Ratnapura and Matale regions, respectively, were studied during the period 1987—1988. They were assessed in early stages of pregnancy (period of gestation less than 20 weeks) and followed up in late pregnancy (period of gestation more than 32 weeks).

METHODS

Their weight, height and mid-arm circumference were measured in early pregnancy using standardised scales. The weight was measured to an accuracy of $\pm$ 0.5 kg (Salter, U.K.), while the height was measured to an accuracy of $\pm$ 0.5 cm using a portable height scale (modification of a scale provided by UNICEF for children). The mid-arm circumference was measured to an accuracy of $\pm$ 0.1 cm using a special paper tape supplied by the Family Health Bureau. The body weights were measured again in late pregnancy and the birth weights of newborn were recorded at delivery.

Information about the income per family, employment of pregnant woman and/or spouse was obtained by means of an interviewer-administered questionnaire. The dietary intake of vitamin A and carotenoids was determined using the 24 hour dietary recall method. For foods which are not consumed daily, the intake during the week was averaged. The vitamin A and beta—carotene content of foods was calculated using tables of food composition (5, 6, 7).

A sample of blood (10 ml) was collected by venepuncture and an aliquot (1ml) was transferred to heparinised bottles and used for the estimation of haemoglobin by the cyanmethaemoglobin method (8). The remainder of the blood was collected into bottles without anticoagulant, centrifuged and the serum was used for the determination of vitamin A, beta—carotene, and retinol binding protein (RBP) concentration. Serum vitamin A concentration was determined by a fluorometric method (9) and beta-carotene concentration by a spectrophotometric method (10). Serum RBP concentration was determined in a randomly selected subsample by radial immuno-diffusion using immunodiffusion plates (LC Partigen RBP, OTUM 04/05) from Behring Diagnostics, Behringwerke, Germany.

All pregnant women were examined for presence of Bitot's spots, conjunctival xerosis, corneal xerosis/ulceration or scarring and keratomalacia. Presence of night blindness was ascertained by questioning pregnant women about their ability to see objects in a poorly-lit room.

RESULTS

The age, parity and income of pregnant women studied are given in Table 1. The income received per family was significantly higher among subjects living in the estate in the Ratnapura region, while the mean age and parity were similar in the three areas.

TABLE 1. Age, parity and income of pregnant women studied

Region	Number of subjects	Age (years)		Parity		Income per family (Rupees/month)	
		Mean	SD	Mean	SD	Mean	SD
Kalutara	26	23.7	5.3	2.3	1.3	806	258
Ratnapura	47	23.9	4.6	2.3	1.3	1413[a]	424
Matale	45	25.6	5.3	2.5	1.2	803	278

[a]Significantly higher than in other regions ($p < 0.001$)

The mean height of pregnant women in all three estates was similar and was less than 1.50 m (Table 2). The body mass index (Quetelet index, kg/m^2) and the mid-arm circumference in early pregnancy were similar among women in all three estates. The mean body mass index (BMI) of women in all three areas was 19.4 ± 1.8 kg/m^2 and 33 women (27.9%) had BMI values less than 18.5 kg/m^2. The mean rate of weight gain (between the 18th and 38th week of gestation) was 0.27 ± 0.12 kg per week and 32.8% of the subjects had weight gains less than 0.20 kg per week. The incidence of low birth weight, abortions and still births was the highest in the estate in Ratnapura region (Table 3).

TABLE 2. Some anthropometric data of the pregnant women at 18 to 20 weeks of gestation and rate of weight gain

Region	No. of subjects	Height (m)		Body mass index (kg/m^2)		Mid-arm circumference (cm)		Rate of weight gain during pregnancy (kg/week)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Kalutara	17	1.44	0.20	19.7	1.7	21.7	1.5	0.30	0.10
Ratnapura	38	1.48	0.05	19.2	1.7	21.2	1.4	0.25	0.10
Matale	38	1.48	0.07	19.1	1.8	21.4	1.1	0.29	0.12
All	93	1.48	0.06	19.4	1.8	21.3	1.3	0.27	0.12

TABLE 3. Pregnancy outcome of women in the study population

Region	Birth weight (kg) All subjects Mean	SD	< 2.5 kg. Mean	SD	Number of abortions	Number of still-births
Kalutara	2.38 (16)	0.75	1.65 (3)	0.74	0	1
Ratnapura	2.55 (36)	0.42	2.16 (14)	0.34	4	2
Matale	2.88 (26)	0.66	1.87 (6)	0.43	2	2

Number of subjects is indicated within brackets.

The haemoglobin levels of women in early and late stages of pregnancy are given in Table 4. The mean haemoglobin level of women in early stages of pregnancy was 9.73 ± 1.72 g/dl. There was no significant difference in the rate of weight gain between the group with initial haemoglobin levels less than 9.7 g/dl and the group with higher haemoglobin levels. However, when initial maternal haemoglobin concentration was less than the mean value of the group (9.7g/dl) the mean birth weight was 2.44 ± 0.48kg which was significantly lower ($p<0.01$) than that observed when maternal haemoglobin concentration was higher (mean birth weight 2.83 ± 0.42 kg). The percentage of subjects having haemoglobin concentrations less than 8 g/dl in early pregnancy was 17.6%, 39.5% and 13.2% respectively, in estates in Kalutara, Ratnapura and Matale regions. These values increased markedly in late pregancy in all areas, with the highest percentage of severely anaemic women in the Matale region (60.6%).

TABLE 4. Haemoglobin levels of women in early and late pregnancy

Region	Haemoglobin (g/dl) Early Pregnancy No. of subjects	Mean	SD	Late Pregnancy No. of subjects	Mean	SD
Kalutara						
All subjects	17	9.56	1.65	17	8.26	1.77
<8g/dl	3	7.10	1.30	6	6.64	1.36
Ratnapura						
All subjects	38	9.07	2.09	32	8.14	2.31
<8g/dl	15	6.78	1.07	15	5.09	0.72
Matale						
All subjects	38	10.5	1.60	33	8.29	2.28
<8g/dl	5	6.92	0.67	20	6.87	1.09
All subjects	93	9.73	1.72	82	8.21	2.11

TABLE 5. Prevalence of ocular mainfestations of vitamin A among pregnant women studied

District	Number examined	Night Blindness (XN)	Conjunctival xerosis (XIA)	Bitot's spots (XIB)	Corneal xerosis (X2), Keratomalacia (X 3) or Corneal scars (XS)
Kalutara	26	1	6	1	—
Ratnapura	47	5	10	5	1
Matale	45	5	14	12	—
All districts	118	11 (9.34%)	30 (25.4%)	18 (15.3)%	1 (0.85%)

A high incidence of early ocular manifestations of vitamin A deficiency was noted among pregnant women in the estates in Ratnapura and Matale regions (Table 5). The percentage of subjects having low vitamin A levels (less than 20 μg/dl) in early pregnancy was less than 10% in estates in Kalutara and Matale regions, while it was higher (18.4%) in the estate in Ratnapura region (Table 6). The percentage of subjects having low vitamin A levels increased markedly in late pregancy and was highest (37.5%) in the estate in the Matale region. All subjects with night blindness had serum vitamin A levels less than 20 μg/dl, while 15 subjects with Bitot's spots too had low vitamin A levels (<20/μg/dl).

TABLE 6. Distribution of vitamin A in the serum in early and late stages of pregnancy

Region	Vitamin A (μg/dl)			No. of subjects with vitamin A		
	No. of subjects	Mean	SD	<20 μg/dl	20—40 μg/dl	<40 μg/dl
Kalutara						
Early pregnancy	17	31.2	6.9	1 (5.9%)	15 (88.2%)	1 (5.9%)
Late pregnancy	17	29.9	9.9	2 (11.8%)	11 (64.7)%	4 (23.5%)
Ratnapura						
Early pregnancy	38	28.5	10.7	7 (18.4%)	26 (68.4%)	5 (13.2%)
Late pregnancy	32	25.2	10.3	10 (31.2%)	19 (59.4%)	3(9.4%)
Matale						
Early pregnancy	38	29.8	6.7	2 (5.3%)	32 (84.2%)	4 (10.5%)
Late pregnancy	32	21.3[a]	5.0	12 (37.5%)	20 (62.5%)	0

[a]Significantly lower than in early pregnancy ($p < 0.001$)

The mean dietary intake of vitamin A (in retinol equivalents) was less than 570 μg/ day in early pregnancy in all three estates, while it increased in late pregnancy, but the change was significant only in the Matale region (Table 7). There was no significant correlation between dietary intake of retinol equivalents and serum vitamin A levels in early and late pregnancy. However, serum vitamin A levels less than 20 μg/dl were seen in 87% of subjects with vitaimin A intakes less than 400 μg/day. There was no significant difference in rate of weight gain during pregnancy or birth weight when mothers with serum vitamin A levels less than 20 μg/dl were compared with those with more than 20μg/dl.

TABLE 7. Dietary intake of vitamin A (retinol equivalents), serum β-carotene and retinol binding protein (RBP) concentration in early and late stages of pregnancy

Parameter	Kalutara Mean	SD	Ratnapura Mean	SD	Matale Mean	SD
Dietary intake of retinol equivalents (μg/day)						
Early pregnancy	469 (17)	268	645 (38)	286	495 (38)	303
Late pregnancy	634 (17)	266	825 (34)	391	887[a] (30)	350
Serum β—carotene (μg/dl)						
Early pregnancy	125 (17)	33	104 (36)	30	112 (38)	39
Late pregnancy	118 (15)	25	107 (30)	36	116 (30)	37
Serum RBP (mg/dl)[c]						
Early pregnancy	3.27 (6)	0.69	2.74 (16)	0.91	2.26 (10)	0.54
Late pregnancy	2.69 (6)	0.76	2.51 (16)	0.71	1.99[b] (10)	0.60

[a]Significantly higher than in early pregnancy ($p < 0.001$)
[b]Significantly lower than in early pregnancy when compared by paired t-test ($p < 0.001$)
[c]Analysed in a randomly selected sub-sample.
Number of Subjects is indicated within brackets.

The serum beta—carotene levels were within the normal range and did not change significantly in late pregnancy. In contrast, the serum RBP concentration, which was less than 3 mg/dl in estates in the Ratnapura and Matale regions, decreased further in late pregnancy (Table 7). The lowest mean values were seen in the estate in the Matale region.

DISCUSSION

The monthly income per family received by most estate workers was higher than the average income of rural low-income families not belonging to the estate sector (11), probably because both members of the family were employed. The average age of pregnant women studied in the estate sector ranged from 23.7 ± 5.3 to 25.6 ± 5.3 years, as compared to a higher mean age ranging from 26.4 ± 4.7 years to 27.9 ± 5.5 years among pregnant women not belonging to the estate sector (11).

The mean heights of women in all three areas was less than 1.50m. The incidence of low birth weight has been reported to be higher among women with a height less than 1.50m (12). The mean body mass index in our study population was only slightly higher than the cut off value (18.5 kg/m^2) indicative of chronic energy deficiency in aduls, despite the fact that they were in early stages of pregnancy (13). There was considerable variation in the rate of weight gain among the subjects studied and the mean rate of weight gain is lower than that reported for industrialized countries (12). It is important to note that 32.2% of subjects had rates of weight gain less tht 0.2 kg per week. This rate was markedly lower than that reported for subjects in the Kandy district (14). Thus the poor nutritional status at the onset of pregnancy (as indicated by low BMI and low haemoglobin levels in

early pregnancy), coupled with nutritional deficiencies during pregnancy may have curtailed the weight gain during pregnancy. This may in turn affect the outcome of pregnancy. The percentage of mothers with infants having low birth weight (less than 2,500g) was markedly higher in the Ratnapura region (38.9%), compared to the country-wide value of 25% reported during the same period.

Anaemia is a major cause of maternal morbidity and mortality (15); it also affects foetal development. Even moderate maternal anaemia (Hb<10g/dl) may cause foetal growth retardation (16) and increased risk of foetal distress (17). Significantly lower birth weights were observed in our study when maternal haemoglobin levels were less than the mean value for the group in early pregnancy. The overall incidence of severe anaemia was 25% in the study population, which increased to 50.6% in late pregnancy despite the distribution of iron/folate supplements (containing 60 mg elemental iron and 0.25mg folic acid) during pregnancy.

A higher incidence of early ocular manifestations of vitamin A deficiency was noted among pregnant estate workers included in our study, compared with pregnant women not belonging to the estate sector of Sri Lanka (11). Serum vitamin A levels less than 20 μg/dl are considered to be low, while those less than 10/μg/dl indicate severe deficiency (18). The percentage of subjects having low vitamin A levels increased in late pregnancy in all areas and 29.6% of pregnant women had low serum vitamin A levels despite an increase in dietary intake of vitamin A during pregnancy. The increase in dietary intake was mainly due to the consumption of a fortified food supplement, thriposha, supplying about 360 μg vitamin A per day.

The absence of a significant correlation between serum vitamin A levels and dietary intake of retinol equivalents suggests that coexisting energy, protein and micronutrient deficiencies may have decreased the efficiency of absorption and transport of the vitamin. The serum RBP levels of women in estates in the Matale and Ratnapura regions were below the normal range in early pregnancy, and decreased further in late pregnancy, the decrease being most marked in the Matale region. RBP not only decreases in vitamin A deficiency but is very sensitive to protein deficiency as well (19). Maintenance of plasma RBP levels during pregnancy is of the utmost importance, as placental transfer of vitamin A is possible only when it is bound to retinol binding protein (4).

These studies show that female estate workers had a poor vitamin A and nutritional status at the onset of pregnancy, which was aggravated by the increased need for nutrients in pregnancy. Estate workers engage in manual work throughout pregnancy and their energy requirements could be expected to be higher than those of other pregnant women.

There fore, nutrition and health education should play a key role towards the long term goal of improving the health and nutritional status of vulnerable groups in the estate sector. A high-energy food supplement or an energy-rich food could be given to estate workers to ensure that their energy needs are satisfied. This would also enable the optimal utilisation of other nutrients, such as protein, iron and vitamin A.

In order to reduce the problem of anaemia in pregnancy, the beneficial effect of iron/folate supplements should be explained to achieve better subject compliance. In areas with a high incidence of vitamin A deficiency, such as the Ratnapura and Matale regions, giving a single oral dose of 200,000 IU of vitamin A at delivery or within a month of delivery is recommended (20). This would have the dual benefit of improving the vitamin A status of the mother, as well as raising the vitaimn A content of breast milk.

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