NUTRITIONAL ANEMIA IN PREGNANCY: A STUDY AT THE MATERNITY HOSPITAL, KUALA LUMPUR*

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ABSTRACT

The study presents recent data on the prevalence and pattern of nutritional anemia in the Maternity Hospital, Kuala Lumpur. A total of 309 pregnant women in their third trimester, of Malay, Chinese and Indian origin from the lower socio-economic strata were randomly selected for the study. Hematological indices (including Hb, PCV, MCHC, and TRBC), serum iron, transferrin saturation and ferritin, serum folate as well as protein and albumin were determined. Based on Hb and PCV values, 30–40 percent of the women could be considered anemic; approximately 50 percent of them presented with unsatisfactory serum iron, transferrin saturation and ferritin values; 60.9 percent had low serum folate levels; and about 30 percent may be considered to be of poor protein nutriture. Anemia in the study population was seen to be related mostly to iron and to a lesser extent, folate deficiency. Hematological, iron, folate and protein status was observed to be the poorest amongst the Indian women, better in the Malay group and generally the best amongst the Chinese women. Birth records of 169 of these women revealed that all of them had live births. Nearly all the infants were delivered by normal vaginal delivery (NVD). The mean gestational age was 38.6 weeks. One of the infants had a birth weight of <2.0 kg; incidence of low birth weight, <2.5 kg, was 8.3 percent. Although there was a trend of deteriorating hematological, iron and protein status of women from the 0, 1–3 and ≥4 parity groups, these differences were not statistically significant.

Introduction

The World Health Organization has long recognized anemia as "a public health problem of considerable importance in the underdeveloped and tropical areas of the world" (1), and has continually emphasized the high prevalence of the problem (2, 3, 4). It has been further noted that there has been no lessening of the prevalence and severity of anemia in the tropics during the past two or three decades (5). Continuing efforts have been mounted towards understanding and characterizing this complex disorder, now known to involve two major hemopoietic nutrients, iron and folate, and to a lesser degree, vitamin B12. There is undoubtedly a widespread and high prevalence of iron deficiency anemia in the world (6, 7, 8, 9). It is in fact thought by some to be the most commonly recognized form of nutritional deficiency in developing countries as well as in affluent societies (10). One estimate is that there are more than 500 million people throughout the world with iron deficiency (11). Next to iron deficiency, anemia due to folate deficiency is the most prevalent (4), especially amongst pregnant women (12). Vitamin B12 deficiencies are known to be relatively rare (4, 12).

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It is now clear that the prevalence of nutritional anemia is particularly high amongst pregnant women as well as in young children. Aptly called the vulnerable groups, hemopoietic nutrient balance is particularly precarious in these individuals. Harrison (13) has estimated that from 5 to 50 percent of all pregnant women attending antenatal clinics in the tropics are found to be anemic, compared with about 2 percent in the developed countries. The prevalence of anemia in pregnant women has frequently been studied and used as an indicator of the prevalence of anemia of the population at large (14).

Studies into the problem of nutritional anemia have been active in Malaysia in the 1950s and 60s. Various efforts were made to characterize the disorder as it occurred in the country. Continued efforts in the 70s and recent years have shown that nutritional anemia is still a major problem here (15), as it is in many parts of the world. Next to studies in children, the problem has been most investigated amongst pregnant women. The earlier major reports in this area were those of Tasker, Richardson and Llewellyn-Jones (16), Tasker (17), Wadsworth and Lee (18), Lourdenadin (19), Llewellyn-Jones (20) and Chong et. al. (21). Recent studies into the problem are few. The studies of Ong (22), and more recently, the studies of George, Adeeb and Ahmad (23), and those of Ali, Khalid and Hamid (24, 25) are of relevance.

This study presents recent data on the prevalence and pattern of the nutritional anemia problem in the largest Maternity Hospital in the country. Attention would of course be on women from the lower socio-economic strata of the population. It is hoped that further studies in other hospitals in the country would be stimulated so as to greater strengthen our knowledge of the problem as faced by this extremely vulnerable segment of the population.

Subjects and Method

For obvious reasons of convenience and ease of obtaining study subjects, the study population was drawn from the nearby ante-natal clinic of the Maternity Hospital, Kuala Lumpur. Subjects from the lower socio-economic strata were requested to participate in the study. During visits to the clinic, the first twenty such subjects registered for their first ante-natal check-up, irrespective of race and age, were taken as subjects for the study. A total of 309 subjects were thus studied.

The weight and height of each subject were recorded. Blood was collected by venous puncture and distributed into a plain bottle and an EDTA bottle. Background information on the subject and information on the outcome of the pregnancy were collected during subsequent visits to the clinic.

Blood in the EDTA bottle was analysed for various hematological parameters (including hemoglobin (Hb), packed cell volume (PCV), mean corpuscular hemoglobin concentration (MCHC) and total red blood cell (TRBC)), performed electronically on an automated hematology analyser (Clay Adams Ultra

Logic 800). Blood in the plain bottle was allowed to coagulate and serum separated for the following analysis:

1. serum iron and TIBC (from which percent transferrin saturation was calculated), determined by a method modified from that described by Jung and Parekh (26);
2. serum ferritin, determined by a Ferritin RIA Kit (Diagnostic Products Corporation, USA);
3. serum folate, determined by the microbiological (*Lactobacillus casei*) assay method of Herbert (27);
4. serum total protein, determined by the standard semi-micro-Kjeldahl method;
5. serum protein electrophoresis, carried out on paper with the albumin quantitated using a Beckman Densitometer.

Differences in mean values of the various parameters between the three racial as well as the different parity groups were tested using the F test for equality of several independent means (analysis of variance — ANOVA). If and when a significance difference was obtained, the "protected" tests were performed to determine which of the groups differed significantly. Differences in proportions of the various parameters (percent of subjects below a certain cut-off value for the parameters studied) between the various racial and parity groups were determined using the chi squared test of equality of several independent proportions. Relationships between the various parameters were analyzed by the Pearson correlation coefficient and tested for significance. In all the above mentioned statistical analyses, only p values of 0.05 and below were considered significant.

Results and Discussion

General characteristics

Some general data of the study population are given in Table I. The population was made up of approximately equal numbers of Malays and Chinese, and a smaller proportion of Indians. No significant difference in mean age between the three racial groups was observed; mean age of the study population was 25.55 years. There was no significant difference in the monthly household income between the Malay and Chinese subjects. Income of the Malay subjects were however significantly higher than that of the Indians ($p<0.01$), and so was that of the Chinese compared with the Indian women ($p<0.001$). Most of the subjects (96.4 percent) were in their third trimester of pregnancy at the time of the study. There were about equal numbers of subjects in the 0 and 1−3 parity groups, and a lower proportion in the >4 parity group. There was no significant difference in the proportions of the three racial groups in both the 0 and 1−3 parity groups. However, in the parity >4 group, there was a significant difference ($p<0.05$) in the distribution of the racial groups. No significant difference in the mean weight and height measurements of the racial groups was obtained, although the mean weight of the Chinese was higher than that of the Malays, which in turn was higher than the mean weight of the Indian subjects.

TABLE I: CHARACTERISTICS OF STUDY POPULATION*

A. Racial Composition

Chinese :	117 (37.9%)
Malays :	121 (39.1%)
Indians :	71 (23.0%)
n :	309 (100%)

B. Age (years)

	Chinese	Malays	Indians	All races
mean	25.78	25.50	25.29	25.55
SD	5.31	5.05	5.66	5.30
range	17–44	17–42	17–42	17–44

C. Household Income per month ($)

	Chinese	Malays	Indians	All races
mean	378.22	358.51	297.17	350.00
SD	134.76	119.79	114.43	127.83

D. Menarche

mean	13.79
SD	1.76

E. Gestational Age at Time of Study

mean (weeks)	33.67
SD	3.92
trimester I	0.3%
II	3.3%
III	96.4%

F. Parity

parity	Chinese	Malays	Indians	All races
0	43(39.1%)	50(44.6%)	23(32.9%)	116(39.7%)
1–3	60(54.5%)	44(39.3%)	33(47.1%)	137(46.9%)
⩾4	7(6.4%)	18(16.1%)	14(20.0%)	39(13.4%)
combined	112(100%)	110(100%)	70(100%)	292(100%)

G. Weight and Height

	weight (kg) mean ± SD	height (m) mean ± SD
Chinese	57.84 ± 7.66	1.54 ± 0.06
Malays	56.13 ± 7.98	1.53 ± 0.06
Indians	55.09 ± 8.90	1.53 ± 0.07
All races	56.54 ± 8.17	1.53 ± 0.06

*Data from Maternity Hospital records, except weight and height.

Hematological status

The mean values of hemoglobin, packed cell volume, mean corpuscular hemoglobin concentration and total red blood cell counts for the study population are tabulated in Table II. Mean Hb and PCV values were only slightly higher than their respective normal limits. Significant differences in mean values for Hb and PCV ($p<0.01$) and RBC ($p<0.05$) were obtained for the various racial groups. For Hb, mean values for the Chinese and Malays were significantly higher than those for the Indians ($p<0.001$ and $p<0.05$ respectively); no significant difference was observed between mean Hb values of the Chinese and Malay groups. PCV values of the Chinese were significantly higher than that of the Malays ($p<0.05$) and the Indians ($p<0.01$); mean values for the Malays and Indians did not show any significant difference. RBC counts for the Chinese were also significantly higher than that for the Malay and Indian women ($p<0.001$), and that for the Malays was significantly higher than the Indian group ($p<0.001$). Analysis of variance showed no significant difference in MCHC mean values for the three racial groups.

Using a cut-off value of Hb < 11.0 g/dl, 43.8 percent of the study population would be considered as anemic (Table II). This proportion is reduced by half to 22.8 percent if the criterion used is Hb < 10.0 g/dl. From this, it can be seen that 21 percent of the subjects lie between the marginal range of 10–10.9 g/dl. Using a cut-off level of < 33 percent, 32.2 percent of the subjects had a low PCV value. Statistically significant differences in prevalence rates of anemia have been obtained using all three hematological criteria (Table II) ($p<0.05$ if Hb < 10.0 g/dl is used, and $p<0.01$ for both Hb < 11.0 g/dl and PCV < 33 percent). As can be seen from the Table II, prevalence was highest amongst the Indians, lesser in the Malay women and lowest for the Chinese.

Hematological status of the Chinese in this study is thus generally seen to be better than that of the group of Malays, which in turn is better than that of the Indians. This is also evident from the tables of frequency distribution of Hb and PCV (Table III and IV), and more clearly seen from Figures 1 and 2, which give the cumulative frequency polygons of these hematological parameters.

Thus, based on Hb and PCV values, about 30–40 percent of the study population would be said to be anemic. This moderately high prevalence rate is comparable with those reported in WHO collaborative studies of pregnant women in the third trimester (using Hb < 11 g/dl) in Venezuela (37 percent) and Isreal (47 percent), but is lower than those in Southern India (57.4 percent), Northern Indian (80 percent) and Burma (82 percent) (cited by Baker and DeMayer (28)).

Iron status

As with the hematological data, the mean values of the parameters of iron status for the study population lie just within the normal limits (Table V). Median ferritin values of the groups is in fact only 11.0 ng/ml.

TABLE II: HEMATOLOGICAL STATUS

racial group	n	hemoglobin (g/dl) mean ± SD	%<10 g/dl	%<11 g/dl	PCV (%) mean ± SD	%<33%	MCHC (%) mean ± SD	TRBC (10^6/mm^3) mean ± SD
Chinese	104	11.48 ± 1.80	17.3	30.8	36.03 ± 4.58	24.0	31.84 ± 3.13	4.12 ± 0.50
Malays	109	11.15 ± 1.51	20.2	47.7	34.75 ± 4.50	31.2	32.12 ± 2.55	3.97 ± 0.51
Indians	63	10.51 ± 1.68	36.5	58.7	33.67 ± 4.42	47.6	31.19 ± 2.47	3.92 ± 0.51
All races	276	11.13 ± 1.70	22.8	43.8	34.99 ± 4.60	32.2	31.80 ± 2.79	4.02 ± 0.52

TABLE III: FREQUENCY DISTRIBUTION OF HEMOGLOBIN

		percentage of subjects with the following Hb levels (g/dl)										
racial group	n	6–6.9	7–7.9	8–8.9	9–9.9	10–10.9	11–11.9	12–12.9	3–13.9	14–14.9	15–15.9	16–16.9
Chinese	104	1.0	3.8	7.7	4.8	13.5	23.1	28.8	12.5	1.9	1.9	1.0
Malays	109	0.9	0.9	2.8	15.6	27.5	14.7	25.7	9.2	2.8	0	0
Indians	63	0	6.3	14.3	15.9	22.2	17.5	17.5	6.3	0	0	0
All races	276	0.7	3.3	7.2	11.6	21.0	18.5	25.0	9.8	1.8	0.7	0.4

TABLE IV: FREQUENCY DISTRIBUTION OF PACKED CELL VOLUME

		percentage of subjects with the following PCV values (%)											
racial group	**n**	**<25**	**25-26.9**	**27-28.9**	**29-30.9**	**31-32.9**	**33-34.9**	**35-36.9**	**37-38.9**	**39-40.9**	**41-42.9**	**43-44.9**	**≥45**
Chinese	104	0	1.0	4.8	8.7	9.6	11.5	23.1	14.4	15.4	4.8	3.8	2.9
Malays	109	1.7	2.8	3.7	6.4	16.5	16.5	26.6	10.1	10.1	0.9	2.8	1.8
Indians	63	1.6	1.6	9.5	7.9	27.0	15.9	7.9	14.3	6.3	7.9	0	0
All races	276	1.1	1.8	5.4	7.6	16.3	14.5	21.0	12.7	11.2	4.0	2.5	1.8

TABLE V: IRON STATUS

		serum iron (μg/dl)		transferrin saturation (%)				ferritin (ng/ml)			
racial group	**n**	**mean ± SD**	**%<50 μg/dl**	**mean ± SD**	**<15%**	**<18%**	**n**	**mean ± SD**	**median**	**range**	**%<12 ng/ml**
Chinese	117	60.18 ± 35.07	45.3	19.45 ± 9.91	38.5	44.4	110	21.86 ± 25.34	13.5	0–180	40.9
Malays	121	48.45 ± 33.53	60.3	15.87 ± 8.44	51.2	64.5	103	11.09 ± 8.80	9.0	0– 68	61.2
Indians	71	47.38 ± 38.88	69.0	15.23 ± 8.39	54.9	71.8	67	12.61 ± 15.32	8.6	0–165	62.7
All races	309	52.65 ± 35.89	56.6	17.08 ± 9.21	47.2	58.6	288	15.69 ± 19.02	11.0	0–180	53.6

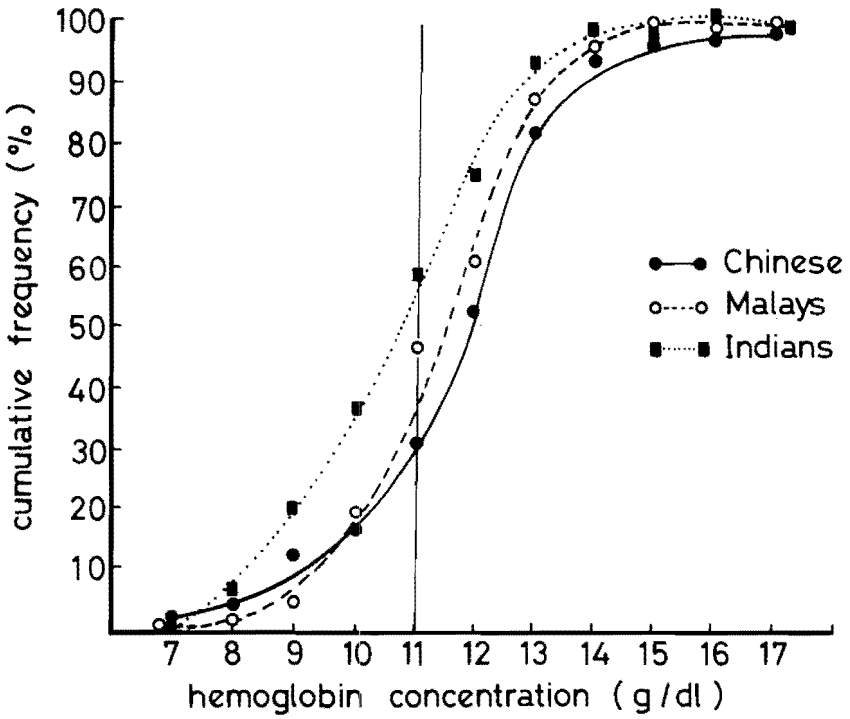

Figure 1. Frequency distribution of hemoglobin concentration of subjects from the three racial groups.

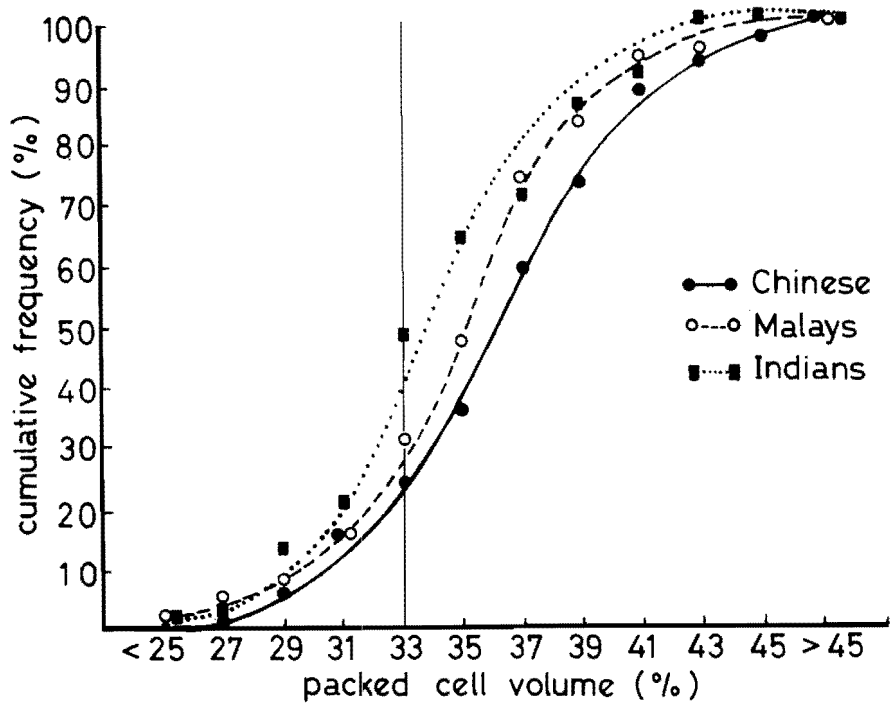

Figure 2. Frequency distribution of packed cell volume of subjects from the three racial groups.

Comparison of these values for the three racial groups has revealed statistically significant differences ($p<0.01$ for Fe and ferritin; $p<0.05$ for TS). Mean value of serum iron for the Chinese subjects was significantly higher than that of the Malays and that for the Indians ($p<0.05$ in both cases); no significant difference was obtained between the Malay and Indian women. Parallel results were obtained for transferrin saturation and ferritin, but with a higher degree of significance ($p<0.01$).

About 50 percent of the women studied had a serum iron level of less than 50 μg/dl, transferrin saturation value of less than 15 percent, and a serum ferritin level of less than 12 ng/ml (Table V). With all four parameters, prevalence of iron deficiency anemia was highest amongst Indian women, less in the Malays and the lowest amongst Chinese women. These differences were statistically significant ($p<0.01$ for both serum Fe and ferritin; $p<0.05$ for TS<15 percent and $p<0.001$ for TS<18 percent).

Thus iron status of the women in this study, as with hematological status, was generally better in the group of Chinese women, worse in the group of Malays and the least satisfactory amongst the Indians. This trend is again clearly evident in the tables of frequency distribution (Tables VI and VII) and cumulative frequency polygons (Figures 3 and 4) of serum iron and transferrin saturation.

A high prevalence of iron deficiency is seen in the women of the study. Based on a transferrin saturation of less than 15 percent, 47.2 percent of them were iron deficient. Similar prevalence rates of iron deficiency (using the same criteria) have been reported in WHO collaborative studies of pregnant women in Poland (40 percent), Isreal (46 percent), Latin America (49 percent) and Northern India (52 percent); but is lower than that for Venezuela (60 percent), Mexico (61 percent) and Southern India (99 percent) (cited by Baker and DeMaeyer (28)).

Folate status

Folate levels of the group of women (Table VIII) showed large variations; values had ranged from 0.1 to 30 ng/ml. Mean folate levels, like other parameters discussed above, are just within the often adopted normal lower limit of 3 ng/ml. There was again a similar pattern of higher mean values in the Chinese women, lower in Malays and the lowest for the Indians; a similar trend was observed for the median values. Mean folate level for the Chinese was significantly higher than that of the Malays ($p<0.05$) and Indians ($p<0.001$); there was no significant difference between mean levels of the two latter groups. This trend in folate status of the racial groups (Table VIII) is also evident in the significant differences in proportions of each group of women with folate levels less than 3 ng/ml ($p<0.001$).

On the whole, 61 percent of the study subjects may be considered as folate deficient, using a cut-off value of <3 ng folate per ml serum. Compared with the WHO studies cited by

TABLE VI: FREQUENCY DISTRIBUTION OF SERUM IRON

		percentage of subjects with the following serum iron values (ug/dl)								
racial group	**n**	**<10**	**10–29**	**30–49**	**50–69**	**70–89**	**90–109**	**110–129**	**130–149**	**≥150**
Chinese	117	0.9	20.5	23.9	16.2	20.5	9.4	5.1	1.7	1.7
Malays	121	2.5	27.3	30.6	24.0	6.6	5.8	0.8	0.8	1.7
Indians	71	2.8	39.4	26.8	14.1	8.5	1.4	0	1.4	5.6
All races	309	1.9	27.5	27.2	18.8	12.3	6.1	2.3	1.3	2.6

TABLE VII: FREQUENCY DISTRIBUTION OF TRANSFERRIN SATURATION

		percentage of subjects with the following % transferrin saturation values										
racial group	**n**	**0–4.9**	**5–9.9**	**10-14.9**	**15–19.9**	**20–24.9**	**25–29.9**	**30–34.9**	**35–39.9**	**40–44.9**	**45–49.9**	**50–54.9**
Chinese	117	5.1	12.8	20.5	12.8	16.2	20.5	4.3	5.1	1.7	0	0.9
Malays	121	3.3	24.0	24.0	20.7	12.4	9.9	4.1	0	0	0.8	0.8
Indians	71	2.8	26.8	25.4	22.5	14.1	4.2	0	1.4	1.4	0	1.4
All races	309	3.9	20.4	23.0	18.1	14.2	12.6	3.2	2.3	1.0	0.3	1.0

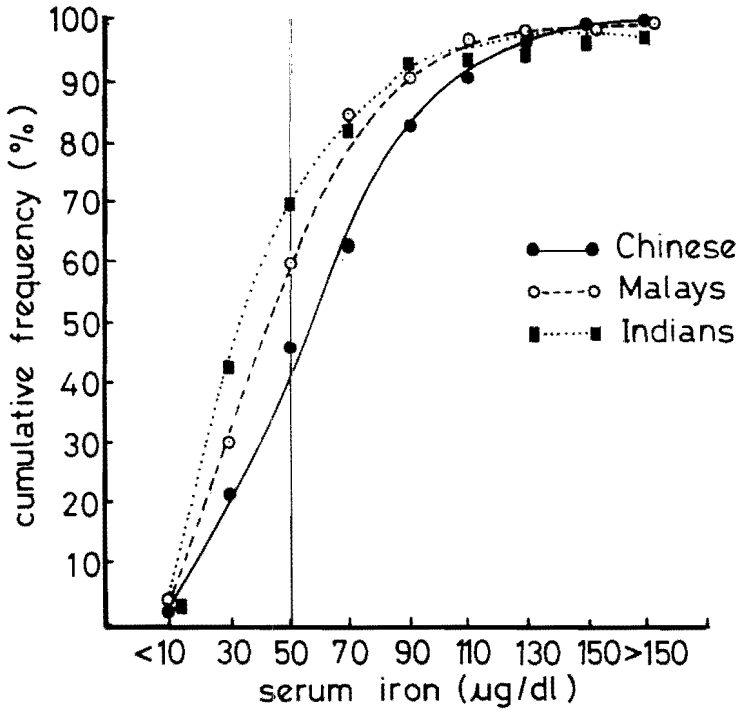

Figure 3. Frequency distribution of serum iron levels of subjects from the three racial groups.

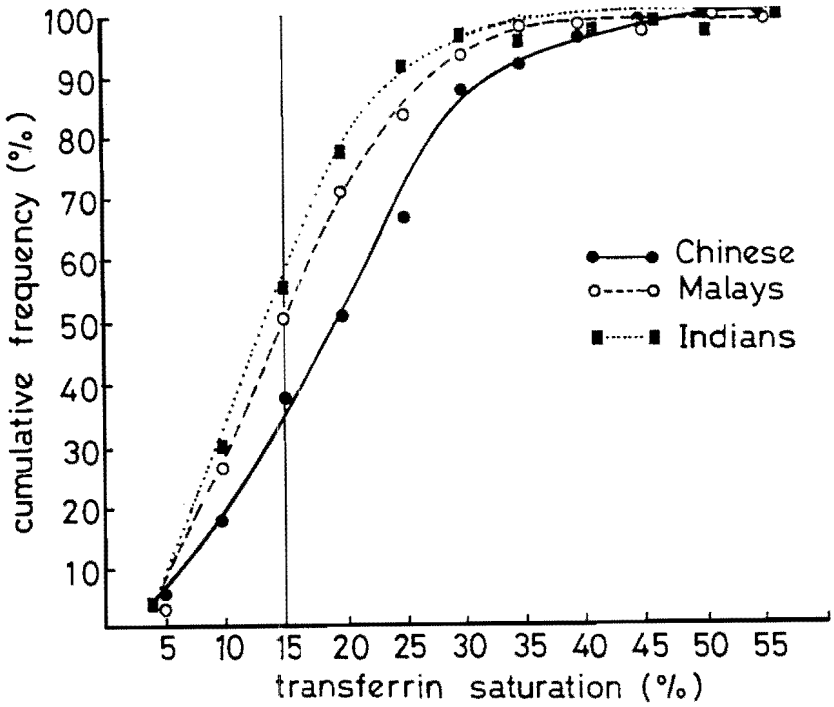

Figure 4. Frequency distribution of transferrin saturation levels of subjects from the three racial groups.

Baker and DeMaeyer (28), and based on the same criterion, this prevalence rate is much higher than the highest rate reported, that of 46 percent for Burma. It is also higher than the rate of 58.5 percent of subjects with serum folate levels <5 ng/ml reported by Ali, Khalid and Hamid (24), also for women of similar socio-economic background at the Maternity Hospital, Kuala Lumpur.

Protein status

Analysis of variance of the mean serum albumin and protein levels of the three racial groups (Table IX) showed a statistically significant difference ($p<0.01$ for both parameters). Mean serum albumin level of the Chinese was significantly higher than that of the Malays ($p<0.001$) and Indians ($p<0.001$), whilst that of the Malays was significantly higher than that of the Indians ($p<0.01$). Serum protein mean levels however showed a trend slightly different to that for the other nutrients thus far considered. Mean level for the group of Malays was significantly higher than that of the Chinese ($p<0.001$), whilst there were no significant differences for the mean levels between the Malays and Indians and between the Chinese and Indians.

TABLE VIII: FOLATE STATUS

racial group	n	serum folate (ng/ml) mean ± SD	median	range	%<3 ng/ml
Chinese	104	4.70 ± 5.06	3.15	0.3–30	45.2
Malays	101	3.30 ± 3.83	2.40	0.1–30	66.3
Indians	66	2.47 ± 2.44	1.60	0.3–14	77.3
All races	271	3.64 ± 4.19	2.40	0.1–30	60.9

TABLE IX: PROTEIN STATUS

racial groups	n	serum protein (g/dl) mean ± SD	%<6 g/dl	serum albumin (g/dl) mean ± SD	%<3 g/dl
Chinese	117	6.03 ± 0.35	36.5	3.24 ± 0.24	11.1
Malays	121	6.21 ± 0.43	23.1	3.11 ± 0.32	25.6
Indians	71	6.13 ± 0.36	25.4	2.99 ± 0.30	46.5
All races	309	6.12 ± 0.39	28.8	3.13 ± 0.30	24.9

Tee et. al. (1984)

Outcome of Pregnancy

Information on the outcome of pregnancy tabulated in Table X, was available for only 169 of the subjects, as there was some difficulty in re-locating the files. Mean gestational age of these women at delivery was 38.6 weeks. Most of the infants (89.9 percent) were delivered at term, i.e. 37 to 42 weeks of gestation. None of them had a gestational period of less than 28 weeks and one of them was delivered post-term. Most of the women (87.6 percent) were delivered by NVD and all the 169 records available were live-births.

Mean birth-weight and length of the infants born of the women studied may be considered to be poor (Table XI). 8.3 percent of the infants

TABLE X: OUTCOME OF PREGNANCY*

1.	Gestation age at delivery	
	mean ± SD (weeks)	= 38.6 ± 1.9
	range (weeks)	= 34 to 44
	34–36 weeks	= 9.5%
	37–42 weeks	= 89.9%
	>43 weeks	= 0.6%
	n	= 169
2.	Outcome	
	livebirth	= 100%
	male	= 91 (53.8%)
	female	= 78 (46.2%)
	n	= 169
3.	Type of delivery	
	NVD	= 148 (87.6%)
	forceps	= 4 (2.4%)
	vac. ext.	= 4 (2.4%)
	asst. br	= 7 (4.1%)
	LSCS	= 6 (3.6%)
	n	= 169 (100%)

*data from Maternity Hospital records

TABLE XI: ANTHROPOMETRY OF INFANTS AT DELIVERY

		weignt (kg)			length (cm)	
racial group	**n**	**mean ± SD**	**%<2.5 kg**	**n**	**mean ± SD**	**%<45 cm**
Chinese	71	3.16 ± 0.35	2.8	70	49.8 ± 1.7	0
Malays	52	3.05 ± 0.43	7.7	50	48.5 ± 2.1	4.0
Indians	46	2.97 ± 0.45	13.0	46	49.0 ± 2.0	2.2
All races	169	3.08 ± 0.41	7.1	166	49.2 ± 2.0	1.8

TABLE XII: FREQUENCY DISTRIBUTION OF BIRTH-WEIGHTS

		percent of births with the following weights (g)					
racial groups	**n**	**1500-1999**	**2000-2499**	**2500-2999**	**3000-3499**	**3500-3999**	**4000-4499**
Chinese	71	0	4.2	28.2	49.3	18.3	0
Malays	52	1.9	7.7	32.7	44.2	9.6	3.8
Indians	46	0	13.0	41.3	37.0	6.5	2.2
All races	169	0.6	7.7	33.1	44.4	12.4	1.8

were of low birth-weight, i.e. less than 2.5 kg and 1.8 percent were of low birth-length (< 45 cm). Birth-weights obtained in this study and the observed racial differences are similar to those reported by Chong and Hanis (29) for a much larger series of births at the Maternity Hospital during 1973, 1975 and 1977.

Significant differences in mean birthweights of infants from the three racial groups were obtained ($p<0.05$). Mean birthweight of infants born to Chinese mothers was significantly higher than of Indian infants ($p.<0.05$). There was however no significant difference between mean birthweight of the Chinese and Malay infants although the former appears to be higher. Similarly, although Malay infants appear to weigh slightly heavier at birth than Indian infants, there was no significant difference. There were also significant differences in birth-length of the infants of different racial origins ($p<0.01$).

Chinese infants were significantly longer than the Malays ($p<0.001$) and the Indians ($p<0.05$). No significant difference in birth-length between Malay and Indian infants was observed. Similar racial differences were observed for the proportions of infants of low birth-weight (< 2.5 kg). This proportion was highest amongst Indian infants, lower in the Malays and the lowest for the Chinese infants. These differences were however not statistically significant. There was also no statistically significant difference in the proportions of infants with low birth-length (<45 cm) amongst the racial groups. The observed racial differences for these anthropometric data of infants at birth is very similar to that observed for the various biochemical parameters discussed above. This is also clearly seen in the frequency distribution (Table XII) and cumulative frequency polygon of birthweights of the different groups (Figure 5).

Correlation of Indices

Significant positive correlations were obtained between Hb and PCV, and a lesser degree between Hb and

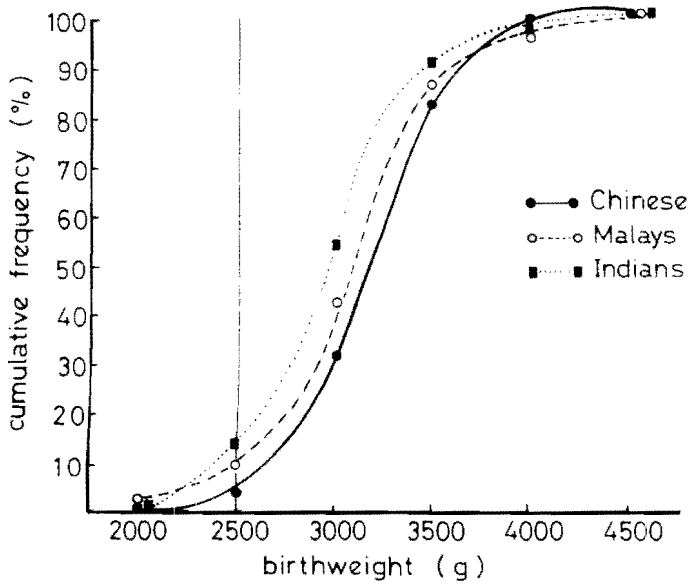

Figure 5. Frequency distribution of birthweights of infants from the three racial groups.

MCHC (Table XIII). Amongst the iron indicators, significant positive correlation was obtained, as shown in Table XIV, between serum Fe and TS; a lesser degree of association was obtained between Fe and ferritin.

TABLE XIII: CORRELATION OF HEMATOLOGICAL INDICES

correlation between Hb and:			
PCV		MCHC	
r	p	r	p
0.764	<0.001	0.530	<0.001

TABLE XIV: CORRELATION OF IRON INDICES

correlation between serum Fe and:			
TS		Ferritin	
r	p	r	p
0.865	<0.001	0.287	<0.001

Correlation studies between Hb and serum Fe and transferrin saturation showed significant positive correlation between these indices (Table XV). A lesser extent of correlation was obtained between Hb and serum folate. These associations would tend to suggest that iron and, to a lesser degree, folate deficiencies played a major role in the anemia encountered in these women. The correlation coefficients obtained in this study are closer to those obtained in the Latin American study reported by Cook *et. al.* (30), but much lower than that of South India reported by Yusufji, Mathan and Baker (31.)

Birthweights of the infants were tested for correlation with Hb, serum iron and folate levels of their mothers. None of these three parameters showed a significant correlation. Thus, it was not possible to demonstrate in this series of subjects the effect of these nutrients on birthweight.

TABLE XV: CORRELATION BETWEEN HB AND INDICES OF IRON AND FOLATE NUTRITURE

correlation between Hb and:					
serum Fe		transferrin saturation		folate	
r	p	r	p	r	p
0.229	<0.001	0.230	<0.001	0.187	<0.01

TABLE XVI: PARITY AND HEMATOLOGY

		hemoglobin (g/dl)			packed cell volume (%)	
parity	n	mean ± SD	% <10 g/dl	% <11 g/dl	mean ± SD	% <33%
0	107	11.36 ± 1.66	18.7	34.6	35.37 ± 4.33	27.1
1–3	122	11.03 ± 1.79	24.6	48.4	34.81 ± 4.85	36.1
⩾4	37	10.88 ± 1.34	24.3	56.8	34.97 ± 3.91	32.4
combined	266	11.14 ± 1.69	22.2	44.0	35.06 ± 4.53	32.0

Parity and anemia

The series of Tables, from XVI to XVIII, show the hematological, iron and protein status of the study population grouped according to parity. Mean values of these parameters, particularly that of hemoglobin, serum iron, transferrin saturation, ferritin and albumin show a decreasing order from the 0 parity group to the ⩾4 parity group. Analysis of variance however, shows no significant differences in all 7 mean values presented in the Tables. There also appears to be a greater proportion of subjects with poor hemoglobin, iron and protein indices in the 1–3 and ⩾4 parity groups as compared with the 0 parity group. Statistical analysis however shows no significant differences in the various proportions of the three parity groups for all 9 parameters tabulated, except for the indicator Hb <11 g/dl ($p<0.05$). These findings would have to be viewed together with the racial composition of the different parity groups, since a racial difference in nutritional status has been demonstrated for the subjects of the study.

Conclusions

This is a relatively small study. Findings here reported certainly cannot be representative of the anemia problem amongst the lower socio-economic women attending the Maternity Hospital, Kuala Lumpur. They however do indicate that the problem exists, and at a moderately high rate. The anemia encountered is expected to be of the iron deficiency type, and to a lesser extent, folate deficiency. This is in line with findings of other earlier investigators in the country and elsewhere. A racial difference in the severity of the problem has been clearly demonstrated,

TABLE XVII: PARITY AND IRON STATUS

parity	n	serum iron (μg/dl) mean ± SD	%<50 ug/dl	transferrin saturation (%) mean ± SD	%<15%	%<18%	n	ferritin (ng/ml) mean ± SD	%<12 ng/ml
0	116	52.82 ± 34.63	57.8	17.11 ± 9.14	44.8	62.1	101	17.50 ± 19.54	45.5
1−3	135	49.70 ± 30.33	57.8	16.88 ± 8.78	49.6	56.3	132	15.15 ± 19.29	56.8
⩾4	39	47.18 ± 30.18	61.5	16.23 ± 9.25	48.7	59.0	36	13.35 ± 17.84	61.1
combined	290	50.61 ± 32.17	58.3	16.89 ± 8.99	47.6	59.0	269	15.79 ± 19.25	53.2

TABLE XVIII: PARITY AND PROTEIN STATUS

parity	n	serum protein (g/dl) mean ± SD	<6 g/dl	serum albumin (g/dl) mean ± SD	%<3 g/dl
0	115	6.16 ± 0.19	27.8	3.17 ± 0.33	20.9
1−3	137	6.11 ± 0.36	30.7	3.13 ± 0.27	26.3
⩾4	38	6.12 ± 0.42	26.3	3.08 ± 0.32	28.9
combined	290	6.13 ± 0.40	29.0	3.14 ± 0.30	24.5

with the Indian women most severely affected. The findings have pointed out there has to be continuous surveillance on the extent and nature of the problem to enable appropriate intervention measures to be implemented. Larger studies, in all parts of the country are clearly needed.

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REFERENCES

1. World Health Organization (1959). Iron deficiency anemia: Report of a Study Group. Technical Report Series No. 182; WHO: Geneva.
2. World Health Organization (1968). Nutritional anemias: Report of WHO Scientific Group. Technical Report Series No. 405; WHO: Geneva.
3. World Health Organization (1972). Nutritional anemias: Report of a WHO Group of Experts. Technical Report Series No. 503; WHO: Geneva.
4. World Health Organization (1975). Control of nutritional anemia with special reference to iron deficiency Report of an IAEA/USAID/WHO Joint Meeting Technical Report Series No. 580; WHO Geneva.
5. *Woodruff, A.W.* (1982). Recent work concerning anemia in the tropics. Seminars in Hematology 19 (2) 141–147.
6. *Baker, S.J* and *Mathan, V.I.* (1981). Evidence regarding the minimal daily requirement of vitamin B12 Am. J. Clin. Nutr. 34: 2423–2433.
7. *Fairbanks, V.F.* (1978). Nutrient deficiencies in man. Iron In: CRC Handbook Series in Nutrition and Food Volume III. Effect of Nutrient Deficiencies in Man *Rechcigl, M* (ed) CRC Press, pp. 183–221
8. *Bothwell, T.H., Charlton, R.W., Cook, J.D.,* et. al. (1979). Clinical evaluation of body iron stores In Iron Metabolism in Man. London, Blackwell Scientific Publications
9. *Royston, E.* (1982). The prevalence of nutritional anemia in women in developing countries a critical review of available information. Wld. Hlth. Statistics Quart No. 2, pp. 52–91.
10. *Dallman, P.R., Siimes, M.A.* and *Stekel, A.* (1980). Iron deficiency in infancy and childhood Am. J Clin. Nutr. 33:86–118.
11. *Finch, C.A.* and *Huebers, H.* (1982). Perspectives in iron metabolism. New Engl. J. Med. 306: 1520–1528
12. *Baker, S.J.* (1978). Nutritional anemia: A major controllable public health problem. Bulletin of the WHO 56: 659–675.
13. *Harrison, K.A.* (1982). Anemia, malaria and sickle cell disease. Clinics in Obstet. and Gynecol. 9 (3) 445–477.
14. *Baker, S.J.* (1981). Nutritional anemias. Part 2. Tropical Asia. Clinics in Hematology 10 (3): 843–871.
15. *Tee, E.S.* (1983). Nutritional anemia: A review of the problem with particular reference to Malaysia (in press).
16. *Tasker, P.W.G., Richardson, A.M.* and *Llewellyn-Jones, D.* (1956). Anemia in pregnancy as encountered in Malaysia. J. Obstet. Gynecol. 63: 409–414.
17. *Tasker, P.W.G.* (1958). Anemia in pregnancy: A five-year appraisal. Med. J. Malaya. 13: 3–10.

18. *Wadsworth, G.R.* and *Lee, T.S.* (1959). Hemoglobin levels of school children in a rural health district of Malaya, and of pregnant women in Malaya and Singapore. J. Trop. Pediatr. 5:67–72.

19. *Lourdenadin, S.* (1964). Pattern of anemia and its effects on pregnant women in Malaya. Med. J. Malaya 19: 87–93.

20. *Llewellyn-Jones, D.* (1965). Severe anemia in pregnancy as seen in Kuala Lumpur, Malaysia. Aust. NZ. J. Obstet. Gynecol. 5: 191–197.

21. *Chong, Y.H., Lourdenadin, S., Thean, P.K., et. al.* (1968). Nutritional status during pregnancy. Far East Med. J. 4: 214–219.

22. *Ong, H.C.* (1973). Hematological values in pregnancy in Orang Asli (aboriginal) women. Med. J. Malaya 27: 240–242.

23. *George, E., Adeeb, N.* and *Ahmad, J.* (1980). Iron stores in pregnancy. Med. J. Malaysia 35: 129–130.

24. *Ali, J., Khalid, H.* and *Hamid, A.* (1981). Suggestion of an active transport of iron to the fetus in human pregnancy and its dependence on maternal serum iron levels. Med. J. Malaysia 36: 215–219.

25. *Ali, J., Khalid, H.* and *Hamid, A.* (1982). Maternal and cord folate and vitamin B12 levels in Malaysians at parturition. Med. J. Malaysia 37: 160–164.

26. *Jung, D.H.* and *Parekh, A.C.* (1970). A semi-micromethod for the determination of serum iron and iron-binding capacity without deproteinization. Am. J. Clin. Path. 54: 813–817.

27. *Herbert, V.* (1961). The assay and nature of folic acid activity in human serum. J. Clin. Invest. 40: 81–91.

28. *Baker, S.J.* and *DeMaeyer, E.M.* (1979). Nutritional anemia: Its understanding and control with special reference to the work of the World Health Organization. *Am. J. Clin. Nutr.* 32: 368–417.

29. *Chong, Y.H.* and *Hanis, H.* (1982). Recent birthweight distribution and trends in Kuala Lumpur. Med. J. Malaysia 37: 40–45.

30. *Cook, J.D., Alvorado, J., Gutnisky, A., et. al.* (1971). Nutritional deficiency and anemia in Latin America: A collaborative study. Blood 38: 591–603.

31. *Yusufji, D., Mathan, V.I* and *Baker, S.J.* (1973). Iron, folate and vitamin B12 nutrition in pregnancy: A study of 1000 women from Southern India. Bull. Wld. Hlth. Org. 48: 15–22.