NUTRITION IN PREGNANCY

Studies in Central America and Panama [1, 2]

Guillermo Arroyave [3]

Institute of Nutrition of Central America and Panama (INCAP), Guatemala, C. A.

SUMMARY

Nutrition during pregnancy is recognized as of great importance in public health, not only for the woman herself, but also for the impact that it may have on the present and future of the born child.

The pregnant state represents additional nutritional needs which have been estimated by expert groups, in a nutrient-independent manner. The percent increase in nutrient specific recommendations due to pregnancy varies with each nutrient. This would mean that the recommended dietary "pattern" for the pregnant woman differs markedly from that of the non-pregnant woman, but this matter needs further study and careful consideration.

In areas like Central America and Panama, where malnutrition is prevalent, pregnant women suffer from the same nutritional deficits as the general population. The main nutritional deficits are calories, protein, vitamin A, ribo-

---

1. This paper was presented at the Workshop on "Latent Effects of Malnutrition and Infection During Pregnancy as Determinants of Growth and Development if the Child", held in Guatemala, January 12-14, 1974. A condensed version appeared in: *Am. J. Dis. Child., 129:* 427-430, 1975.
2. The cooperation of Dr. Fernando E. Viteri, Dr. Aaron Lechtig and Dr. Miguel A. Guzmán in the preparation of this work is gratefully acknowledged.
3. Chief, Division of Physiological Chemistry of the Institute of Nutrition of Central America and Panama (INCAP), Guatemala City, Guatemala, C. A.
   INCAP Publication I-829.

Recibido: 10-11-1975.

flavin, iron and folates. In some instances like in the case of iron and calories, the deficit seems greater in the pregnant women than in the population at large. The studies give evidence that the new born children of malnourished mothers reflect in some aspects the biochemical changes found in the pregnant women.

INTRODUCTION

Public Health Significance of Nutrition in Pregnancy

Shôrtly after beginning my efforts to write an appropriate introduction for this presentation I gave up my hope to be original. The reason was the realization that the importance of maternal nutrition has previously been treated so much and so well. Through my reading, I came accross the thoughts of the Technical Group of PAHO on "Maternal Nutrition and Family Planning in the Americas" [1] and could not resist quoting from one of its statements:

"Nutritional needs increase during pregnancy and lactation, and pregnant and lactating women form an important vulnerable group, exposed to special risks if their dietary needs are not met. In nearly all communities, the mother is chiefly responsible for care within the family of infants and dependent children, and poor maternal nutritional status may have serious consequences for such children. Since the mother is the necessary link between any health service and the fetus and young child, maternity and child health services should be combined.

From the immediate nutritional point of view, the maternal diet should provide sufficient of the nutrients required to maintain the mother and the fetus in good health during pregnancy, to support an adequate flow of breast milk without detriment to maternal nutritional reserves, and finally, to maintain maternal health between pregnancies. Yet it should not be forgotten that the children of today are the parents of tomorrow. The maintenance of a good nutritional state among growing children and adolescents is therefore a most important, possibly *the* most important, aspect of long-term nutritional policies".

Nutritional Needs Due to Pregnancy

No one would question the fact that the nutritional needs of women of reproductive age are substantially increased during pregnancy. Expert groups responsible for drawing recommended

dietary intakes have recognized this, and derived "allowances for pregnancy". In general the basis for these extra allowances are the physiological needs of the pregnant organism plus the necessary materials that ought to be accumulated for a normal product, plus, mainly in the case of calories, a reserve recognized to be necessary for lactation.

Data derived in such ways by different expert groups and committees of WHO and FAO were adapted to the Central American population in its environment [2], to produce the daily dietary recommendations presented in Table 1.

TABLE 1

DAILY DIETARY RECOMENDATIONS
INCAP, 1973

Nutrient	Pregnant [1] (2nd & 3rd trimester)	Non-pregnant	Allowance for pregnancy	% Increase
Energy (kcal)	2400	2050	350	17
Protein (g)	60	45	15	33
Calcium (mg)	1100	450	650	144
Iron (mg)	28	28	—	—
Vitamin A (μg)	900	750	150	20
Thiamine (mg)	1.0	0.8	0.2	25
Riboflavin (mg)	1.3	1.1	0.2	18
Niacin equiv. (mg)	15.8	13.5	2.3	17
Ascorbic acid (mg)	50	30	20	67
Folate (free) (μg)	400	200	200	100
Vitamin B_{12} (μg)	3.0	2.0	1.0	50

1 > 18 yrs old.

Incap 74-1

Tables like this should not be presented without a statement about their meaning and interpretation: with the exception of calories, the recommended figures represent intakes considered necessary to satisfy the metabolic needs and maintain health in practically all persons in a specified group. This means that they should not be used as the only and absolute criterion to judge nutritional status of individuals. Deviations of individual intakes from the recommended figures are only suggestive, and are meaningful only as guidance to determine the types of further

information needed regarding past nutrient intake, clinical evidence, nutritional biochemical characteristics and growth and development. Since recommendations are set up at the upper level of the distribution curve of requeriments most individuals consuming them would be amply covered in theory.

For calories the situation differs fundamentally. Because it is fully recognized that the consumption of more energy than actually spent is underisable, the estimated average *requirement* of the population is the recommended figure for the non-pregnant woman. For the pregnant woman, however, the Committee [3] took a more liberal approach, recognizing that "a safe level of energy intake is a basic requeriment to ensure satisfactory nutrition for the fetus and breast-fed infant". The recommended intake therefore is set to provide for a storage through pregnancy of about 36,000 kcal as adipose fat reserves.

The last column of this Table is puzzling. It indicates that if the diet of the woman before pregnancy is adequately supplying all the nutrients in amounts and proportions according to the recommended intakes, then a simple increase in pregnancy of 17% in consumption of that diet to satisfy the increase in caloric need, would leave in deficit several nutrients, particularly calcium, ascorbic acid, proteins, folate and vitamin B_{12}. It implies the need for a drastic change in the dietary *pattern* during pregnancy. It makes one wonder if this peculiar pregnancy pattern is real or the outcome of the relative enthusiasm and success of specialists in some nutrients over others.

Table 2 presents the results of an excercise carried out to estimate in practical terms how a pregnant woman in a typical rural village in Guatemala could fill her dietary gap due to pregnancy. It can be seen that four spoonfuls of black beans, two tortillas, half an ounce of cheese, half of a tomato and one leaf of cabbage would accomplish the job leaving an unimportant deficit in calcium and niacin and a notorious deficit in vitamin A. The foods were selected among those available to the community which form part of their regular diet. Under these ecological conditions, the gap in vitamin A cannot be filled but by supplementation. The last horizontal line of the Table gives an "upper limit" estimate of cost. Between 6 and 7 Quetzales (1 Quetzal = 1 U.S. Dollar) would be spent in the last 6 months of pregnancy for these extra foods.

TABLE 2

"COST" OF PREGNANCY

(Rural Indian Community, Altiplano of Guatemala, 1972)

Nutrient	Beans 4 spoons (cooked)	Tortilla 2 U. (yellow)	Cheese 15 g	Tomato ½ U.	Cabbage 1 leaf	Total	Allowance for pregnancy [1]
Energy (kcal)	108	186	65	5	6	368	350
Protein (g)	7	5	4	0.2	0.4	16.6	15.0
Calcium (mg)	28	142	341	1	10	522	650
Iron (mg)	2.4	2.2	0.2	0.1	0.2	5.1	0
Thiamine (mg)	0.2	0.1	0.05	0.01	0.01	0.37	0.20
Riboflavin (mg)	0.06	0.04	0.01	0.01	0.01	0.2	0.2
Niacin (mg)	0.6	1.0	0	0.1	0.1	1.9	2.3
Retinol (μg)	0	14	29	13	2	58	150
Cost (cents)	1.3	1.0	1.0	0.5	0	3.8	—

1 INCAP, 1973.

INCAP 74-2

NUTRITION OF PREGNANT WOMEN IN CENTRAL AMERICA

Dietary Intake Patterns and Nutrient Intake

Following is an account of some studies which have been done at INCAP about dietary patterns and nutrient intake of women, as these may be affected by pregnancy and lactation.

Beteta and Flores [4] carried out in 1963 a dietary survey to assess directly the nutrient intake of pregnant and lactating mothers in a Guatemalan village. At the same time they collected data on the general population. A lower adequacy was noticed for the lactating women. Observation of the actual intakes revealed that in general this was caused by their higher recommended allowances rather than by a lower consumption. An exception is vitamin A, in which case, both a decreased consumption and an increased recommended allowance resulted in a very low adequacy. In the case of this nutrient, pregnant women are in the same situation. In general, therefore, the pregnant women increased their nutrient intake in this village, to compensate for the increased demand, with the exception of vitamin A; but the lactating women did not.

A similar conclusion with regard to pregnancy is derived from the study conducted later (1967-68) by Flores *et al.* [5] in two "ladino" villages in the rural area of Guatemala. Table 3 summarizes these findings. In this study the data were collected by monthly 24-hour recalls in a longitudinal way and the results are pooled from the two villages for the first, second and third trimesters. The general trend in both villages is an increase in food consumption during the last two trimesters. This comprises mostly corn and vegetable foods representing an increment in caloric intake of around 400 cal/day over the 1500 cal being consumed during the first trimester. This was accompanied by a variable increase in the intake of other nutrients. Animal protein was stationary at a low level of intake or even tended to decrease in one of the villages. Please notice that, calories, iron, riboflavin and vitamin A are, of the nutrients estimated, those in most marked deficit. Calories are definitely more deficient than proteins; the intakes would be insufficient even for a non-pregnant non-lactating woman. An interesting piece of information is the consistent decrease in food intake in the lactating woman in relation to the third trimester of pregnancy which translates into about 200 calories but proportionally affects more drastically riboflavin, vitamin A and vitamin C. The reasons for this are unknown but the fact

suggests a change in dietary pattern which may have cultural roots. The three last vertical columns correspond to 43 rural low socioeconomic children of Guatemala also, and they are included for the sole purpose of illustrating the fact that the relative adequacy figures are surprisingly similar to those for the pregnant mother: the same nutrients occupy the positions of larger deficits principally calories, vitamin A and riboflavin. This emphasizes the position of the Technical Group of PAHO on Maternal Nutrition and Family Planning in the Americas [1] who stated: "It is unrealistic to consider the nutrition of pregnant and nursing mothers in isolation. They are members of their family groups and of their social environment. Public health measures should therefore be directed toward the improvement of nutritional conditions in societies as a whole, as well as in family groups".

The question of whether the dietary pattern is changed by women during pregnancy was also investigated in a qualitative study by Arroyave *et al.* [6] in Guatemala. They surveyed 14 pregnant women of each, the high socioeconomic and the low socioeconomic groups. The women in the high socioeconomic group changed their pattern more, introducing more milk, eggs, fruits and vegetables and reducing cereals and fats. This change suggests the influence of nutrition education. In the low income group few women changed their pattern and more their total food consumption. The only frequent change was an increase in fruits.

With the extensive data collected during the Central American Nutrition Survey [7] we have made a comparison of the adequacy of caloric intake of families who had pregnant and/or lactating women among them, with those families without. To express the results in some standardized manner we have calculated the percent of families in each category who had an adequacy of 75% or less compared with the weighted recommended allowances. The effect is shown in Table 4. The presence of pregnant women resulted in a lower adequacy in 4 countries. It is obvious that the effect observed may be caused by (a) the increased recommended allowances of pregnancy and lactation combined with a decrease in absolute nutrient intake; and (b) by the increased recommended allowances with no increase in nutrient intake to compensate for the higher demand. In the case of lactation at least the data previously discussed (Table 3) indicate that the explanation is that given under (a). Whatever the case, the results emphasize the need to give attention to this problem through nutrition aducation and supplementation programs.

TABLE 3

ADEQUACY OF DIETARY INTAKE

(Low Socioeconomic Rural, Guatemala)

Nutrient		Pregnant (Trimester) 1rst (n=20)	Pregnant (Trimester) 2nd (n=57)	Pregnant (Trimester) 3rd (n=57)	Lactating (n=36)	Child (2 yrs.) Adequancy % 5 (n=43) Q1	M	Q3 6
Energy [3] (kcal)	Intake	1418	1723	1819	1599			
	Adeq. % [1]	64	72	76	62	50	66	80
	Adeq. % [2]	69	84	89	78			
Protein [3] (g)	Intake	39	50	54	58			
	Adeq. % [1]	87	83	90	85	57	74	97
	Adeq. % [2]	87	111	120	129			
Animal protein	Intake	8	7	9	10	—	—	—
Calcium [3] (mg)	Intake	768	967	1012	887			
	Adeq. %	171	88	92	81	47	69	100
Iron [3] (mg)	Intake	17	17	20	21			
	Adeq. %	61	61	71	75	43	71	107
Riboflavin [3] (mg)	Intake	0.68	0.71	0.79	0.58			
	Adeq. %	57	55	61	41	26	46	66
Thiamine [3] (mg)	Intake	0.81	0.99	1.07	1.03			
	Adeq. %	90	99	107	103	68	92	122
Vitamin A [4] (mg)	Intake	0.47	0.53	0.75	0.34			
	Adeq. %	36	33	47	16	10	30	69
Vitamin C [3] (mg)	Intake	36	29	39	13			
	Adeq. %	120	58	78	26	16	60	108

(1) Adequacy relative to recommendations for pregnant women.
(2) Adequacy relative to recommendations for non-pregnant women.
(3) INCAP, 1973.
(4) INCAP, 1965.
(5) INCAP, 1968.
(6) Q_1 = First quartile; M = Median; Q_3 = Third quartil

TABLE 4

ADEQUACY OF CALORIE INTAKE OF FAMILIES WITH PREGNANT OR LACTATING WOMEN COMPARED TO THOSE WITHOUT

(Rural Area, 1965-67)

(Percent of families with an adequacy of 75% or less)

	Families with pregnant	Families with lactating	All families without
Guatemala	14	18	12.0
El Salvador	33	26	16.0
Honduras	24	43	31.0
Nicaragua	25	49	24.0
Costa Rica	50	37	28.0
Panama	28	36	15.0

Incap 75-1153

Biochemical-Nutritional Characteristics

The following is a review of the studies which have been carried out by INCAP on the nutrition of pregnant and lactating women. In 1958 Arroyave *et al.* [8] reported an investigation of the riboflavin nutritional status of pregnant women from a low-medium socioeconomic group in Guatemala City. The samples were 33 mothers attending the prenatal care clinic of the Social Security Institute. At the time of the study all were between the 27th and the 32nd weeks of pregnancy.

To judge the state of riboflavin nutrition the subjects were submitted to a "load-retention test", which consisted in the parenteral administration of 1 mg of pure riboflavin and the measurement of the absolute quantity of the vitamin excreted in the urine during the following 4 hours. The results are shown in Figure 1. It was concluded that only 13 of the 33 women had excretions compatible with adequate intakes of riboflavin, that is, 4-hour excretions of 200 μg or higher. Six of them retained over 90% of the injected dose, indicating high "insaturation" of the tissues. The Figure also illustrates, as point of practical importance, the close relationship between the intake of animal food sources of riboflavin, principally milk, with "tissues saturation", indicating the minor role which the vegetable foods of the diet play as sources of this important vitamin.

In another investigation reported in 1960, Arroyave *et al.* [6] compared some biochemical-nutritional indices between two groups of pregnant women: forty-seven women from the low socioeconomic level (Amatitlán, Guatemala) and 26 of high socioeconomic level (Guatemala City). This study, which included the three trimesters of pregnancy showed significantly lower levels of red blood cell riboflavin, serum vitamin A and carotene, hemoglobin and hematocrit, for the low socioeconomic group. The total serum proteins did not differ. Albumin was not determined.

Beaton, Arroyave and Flores [9] made an attempt to find changes in plasma proteins and their paper and starch-gel electrophoresis fractions which would indicate inadequate protein nutrition in pregnant women of low socioeconomic level. The findings were compared with those in pregnant women of the high socioeconomic group. The values were found essentially the same in both groups. The authors suggest several possible explanations: "1) due to nutritional and physiologic adaptations, dietary protein requirements do not increase appreciably during pregnancy and lactation; 2) protein intake, although frequently below the recommended levels, was sufficient, even in the low socioeconomic groups, to meet the added requirements of pregnancy and prolonged lactation; 3) the methods employed were not sufficiently sensitive to detect the effects of a dietary inadequacy".

Beteta [4] in his study of a group of pregnant women of a low socioeconomic ladino rural village in Guatemala, found biochemical evidence of inadequate riboflavin intake, that is, low urinary riboflavin excretion and reduced levels of red blood cell riboflavin. Furthermore, he found a pattern of plasma free-amino acids suggestive of an inadequate protein intake, as shown by a low ratio of valine/glycine (Table 5). It is interesting that the new born children from these mothers (cord blood) also showed this alteration indicating an effect of the nutrition of the mother. The significance of this finding in terms of the nutrition and development of the fetus may be of importance.

In a recent study being conducted at INCAP with the objective of determining differences in placental composition in two groups of urban mothers of low and high socioeconomic level in Guatemala [10], a number of biochemical and physical measurements were taken in order to characterize the subjects' nutritional status. The socioeconomic level was defined by the monthly family income, environmental sanitation of the house and educational level of the mother. Both groups were matched for age, parity, interval with the previous delivery and absence of severe disease during pregnancy. Only the uncomplicated full-term pregnancies

TABLE 5

PLASMA VALINE AND GLYCINE IN POPULATION GROUPS HAVING DIFFERENT NUTRITIONAL CHARACTERISTICS

	Group	Nº	Valine (mg/100 ml)	Glycine (mg/100 ml)	Ratio
1	Pregnant women Guatemala City (UIU) (1)	5	1.491	1.210	1.298
2	Pregnant women S. Ant. P. (LIR) (1)	6	0.998	1.599	0.636
3	Non-pregnant women S. Ant. P. (LIR)	7	1.447	2.643	0.587
4	Newborn children Guatemala City (UIU) (2)	5	2.392	2.531	0.947
5	Newborn children S. Antonio La Paz (LIR) (3)	6	2.002	2.970	0.710
6	Well-nourished children 3-6 years of age	5	1.679	1.606	1.093
7	Children with kwashiorkor 2-6 years of age	6	0.275	1.577	0.184
8	Children with marasmus 1 year of age	1	0.456	1.266	0.360
		1	0.584	1.596	0.366

(1) UIU Upper income urban; LIR Low income rural. Ninth month of pregnancy.

(2) Cord blood from group 1.

(3) Cord blood from group 2.

resulting in male newborns were included. Special attention was given to five nutrients which were expected to be discriminatory variables in the diets of the two groups: proteins, calories, vitamin A, riboflavin, iron and folic acid. The selection was made on the basis of the dietary and nutritional findings of the population at large to which the pregnant belonged. Some pertinent results of this study will be discussed here in some detail.

Protein, calories. The distribution of urinary excretion of urea per gram of creatinine shown in Figure 2, was significantly different between the two groups when a value of 4 g urea N/g creatinine was taken as the discriminatory level. A rationale, derived *a posteriori* from basic nutrition concepts, gives biological meaning to the ratio of 4 g urea N/g creatinine: the urinary urea N/creatinine ratio determined in "fasting" urine from pregnant women ingesting their recommended allowance of ideal protein could be predicted like this: the safe level of ideal protein intake for a 55 kg woman is 29 g/day [3]. For the Central American woman weighing 51.1 kg the need is 27 g/day [2]. To this, 9 g/day are added for pregnancy during the second and third trimesters.

$$27 + 9 = 36 \text{ g/day}$$

With this low intake about 70% of the urinary nitrogen is expected to be urea N [11-14]. Therefore, $36 \times 0.7 = 25.2$ g protein equivalent. Then, $25.2/6.25 = 4$ g urea nitrogen. One can estimate that the desirable creatinine excretion per 24 hours of the women would be about 1.0 g. The average plus 1 S.D. for the high socioeconomic women is 1.0 g of creatinine per 24 hours. Therefore, an excretion of urea N of less than 4 g/g creatinine (or 24 hr) is undesirably low.

An immediate biochemical consequence of the above is a marked highly significant difference in the Whitehead's plasma non-essential/essential amino acid ratio which is obviously abnormally elevated in the women of the low socioeconomic group as shown in Figure 3. The results of the previous study already mentioned are further documented and confirmed, demonstrating unequivocally that the amino acid ratio of the newborn is also markedly affected by the nutrition of the pregnant woman. The difference is also highly significant ($P<0.01$) and is also shown in Figure 3.

A gross manifestation of this nutritional limitation in proteins should be revealed by physical measurements, but of course, other deficiencies, particularly caloric, confound the interpretation. The

TABLE 6

SERUM PROTEIN FRACTIONS IN PREGNANT WOMEN AT DELIVERY IN TWO SOCIOECONOMIC GROUPS

Socioeconomic level		Albumins (mg/100 ml)	Globulins (mg/100 ml) α_1	α_2	β	γ
High	N	18	18	18	18	18
	$\bar{x}$	3.28	0.43	0.92	1.14	1.25
	SD	0.294	0.100	0.245	0.190	0.243
Low	N	30	30	30	30	30
	$\bar{x}$	3.49	0.44	0.91	1.31	1.15
	SD	0.222	0.055	0.127	0.193	0.253
t		2.50*	0.37	0.017	3.09**	1.41

* $P < 0.05$.
** $P < 0.01$.

Incap 75-1155

TABLE 7

SERUM PROTEIN FRACTIONS IN CORD BLOOD IN TWO SOCIOECONOMIS GROUPS

Socioeconomic level		Albumins (mg/100 ml)	Globulins (mg/100 ml) α_1	α_2	β	γ
High	N	20	20	20	20	20
	$\bar{x}$	3.23	0.18	0.38	0.46	0.98
	SD	0.336	0.170	0.071	0.090	0.208
Low	N	30	30	30	30	30
	$\bar{x}$	3.38	0.20	0.41	0.50	1.10
	SD	0.400	0.055	0.120	0.185	0.182
t		1.43	0.52	1.11	1.05	2.18*

* $P < 0.01$.

Incap 75-1154

TABLE 8

PERCENT OF WOMEN WITH DEFICIENT AND LOW SERUM FOLATE LEVELS

Group	"Deficient" (<3.0 ng/100 ml)	"Low" (3.0-4.9 ng/100 ml)	Origin
High Socioeconomic:			
Pregnant (9)	0%	11%	Guatemala City
Low Socioeconomic:			
Pregnant (121)	17%	41%	Guatemala City
Non-pregnant (535)	33%	34%	Rural Central America

Figures in parenthesis are number of cases.

Incap 74-6

weight for height of the women of the low socioeconomic group is significantly lower [10], and the tricipital skinfold thickness is also lower [10], which indicates a deficit in caloric adequacy. The creatinine excretion per 24 hours is a reflection of total muscle mass. In Figure 4 the values are shown. The distribution of the values is not normal and, accordingly, instead of comparing the means, it appeared more appropriate to compare the distributions of the values. For the purpose, a set reference point was chosen, namely the median value for the high socioeconomic group. The proportion of values below this reference point in the low socioeconomic group was compared with the expected value of 50%. A difference was found, as 22 out of the total of 29 low socioeconomic women fell below the reference value. This, of course, could be normally due to the difference in height of the women, since the averages are 150 cm for the low and 162 cm for the high socioeconomic groups, respectively. This question may be resolved by expressing the creatinine excretion per centimeter of body height (Fig. 5). When this is done, a difference persists in favor of the high socioeconomic group, indicating a relative protein depletion in the low socioeconomic group.

If the caloric reserves (adipose tissue) were the same in both groups, one would expect the creatinine coefficient (mg creatini-

ne/kg) to be also lower in the low socioeconomic women. The results are shown in Figure 6. The difference in the distribution of values tested as described before, shows the opposite, that is, in the low socioeconomic group, the proportion of creatinine coefficients above the set reference point (74%), is significantly larger than 50%. These higher creatinine coefficients for the low socioeconomic group indicate that the lower weight for height of these women is due partly to a decreased protein mass, plus an even more drastic decrease in caloric reserve. All these data demonstrate the effects of a caloric limitation in the dietary intake of the women of low socioeconomic level.

The plasma protein fractions (Tables 6 and 7) indicate that the calorie-protein deficit noted has not resulted in an abnormal picture. In fact, practically all the fractions tend to be higher in the low socioeconomic women, but the difference is significant only for albumin and beta globulin. This normal or increased plasma protein in chronically undernourished pregnant women has been described before and is attributed to a reduction in the physiological increase in blood volume characteristic of the last stages of normal pregnancy [6]. It could be that a relative predominance of caloric over protein deficit is responsible for this "maintenance" of the plasma protein picture, in the same manner as in marasmic children [14].

Vitamin A. Average serum retinol levels of the mothers during delivery and the corresponding cord blood are presented in Figure 7. The high socioeconomic group had higher values but while the difference in the pregnant women was highly significant, in the corresponding cord bloods it was not when assessed by "t" test. Nevertheless, the distribution of the cord blood values points to a marked difference. For general populations, values below 10 μg/100 ml are considered "deficient" [15]. Although this criterion may not be directly applicable to cord blood, no better criterion is available. On this basis, 11 out of 30 cases (37%) in the low socioeconomic group, while only 3 out of 20 (15%) in the high socioeconomic group, are in the "deficient" category.

Figure 8 illustrates the relationship between the retinol levels in the mothers' serum and those in the cord blood serum. There is a tendency towards a correlation which did not reach significance. However, the analysis by arbitrary discriminatory intervals of the womens' values indicates that as these increase, the cord blood values increase also, but at a lower rate. This interesting relationship indicates a placental barrier to retinol,

perhaps as a protecting mechanism to the sensitive tissues of the fetus against unfavorably high concentrations of retinol.

Riboflavin. The data from previous studies discussed already had given evidence of inadequate riboflavin in the diet. Since the urinary excretion of this water-soluble vitamin is related to intake [16], it was measured in the two groups of women and related to the excretion of creatinine. Figure 9 compares the distribution of the results showing that more than half of the values of the low socioeconomic group fall in the inadequate categories [15] while 90% of the values in the high socioeconomic group are either "acceptable" or "high". The difference is highly significant. Although the functional and clinical consequences of this for the mother of the child were not measured, it is obvious that the dietary supply of riboflavin to the mothers of the low socioeconomic group is notoriously below desirable levels.

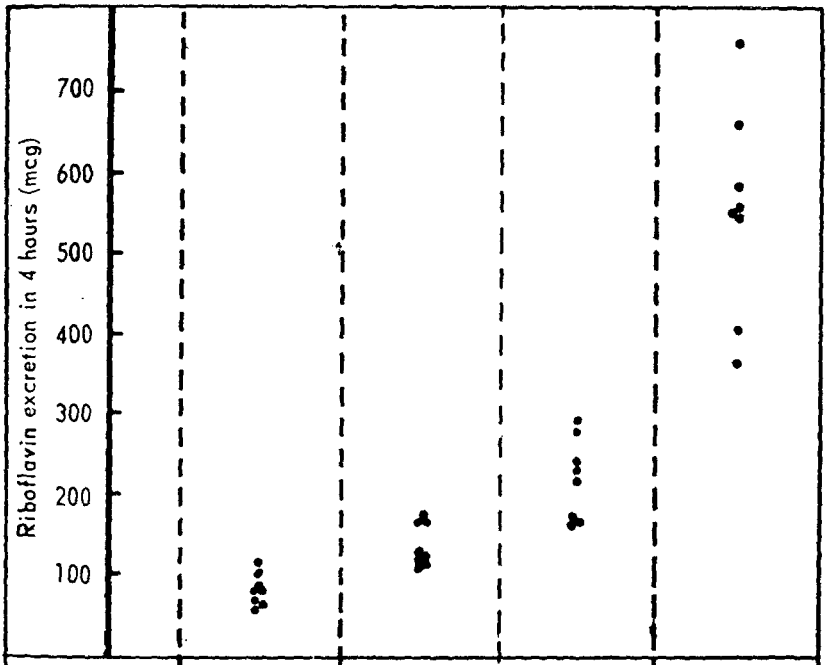
Anemia studies (iron and folates). The problem of anemia in the population of Central America was evaluated during the nutrition survey [7], and the data obtained permit a comparison of pregnant women with their non-pregnant/non-lactating counterparts. The results show that pregnant women in all the six countries have a higher prevalence of iron deficiency indicated by the degree of transfering saturation. This is hown in Figure 10.

The role that folate nutrition may be playing as a limiting nutrient in the etiology of anemias in the populations of the area, and particularly in pregnant women, has been investigated at INCAP by Viteri [17]. For the general population, the evidence points to the fact that folates are limiting in the diets but that their deficiency does not manifest itself hematologically because iron is the first limiting factor for hematopoiesis giving a microcytic hypochromic picture. When iron is administered to these people the already low folate blood levels fall even further and folate becomes the limiting hematopoietic nutrient.

Pregnant women are not an exception to this. In the low socioeconomic group the percent of cases with a "deficient" (<3 ng/100 ml) and "low" (3-4.9 ng/100 ml) serum levels was very high in an urban group of pregnant women attending a public hospital in Guatemala [10, 17] as shown in Table 8. The data in non-pregnant low socioeconomic women [7] are included to show that the prevalence of "deficient" and "low" values is also very high, but the sample is not quite comparable since the latter comprises all the Central American rural area. Of nine pregnant women belonging to the high socioeconomic urban group in

Guatemala City [10] none had "deficient" serum levels and only one was with a "low" value.

In conclusion, iron seems to be the first hematopoietic limiting factor, its deficiency obscuring the manifestations of folate deficit in the body. This is true for the general population of adults and it reflects in the pregnant women.



Riboflavin daily Intake from animal foods (mcg)	276	381	671	1262
Food Intake/ week				
milk (glasses)	1.1	1.8	4.8	11.2
eggs (units)	0.9	1.6	3.0	4.8
meat (ounces)	16.4	17.1	14.5	21.0
cheese (ounces)	1.6	2.0	4.0	3.9

MEDIAN: (171 *mcg urinary riboflavin in 4 hrs*)

Incap 69-995

Fig. 1

Excretion of urinary riboflavin in pregnant women (Amatitlán, Guatemala, 1958).

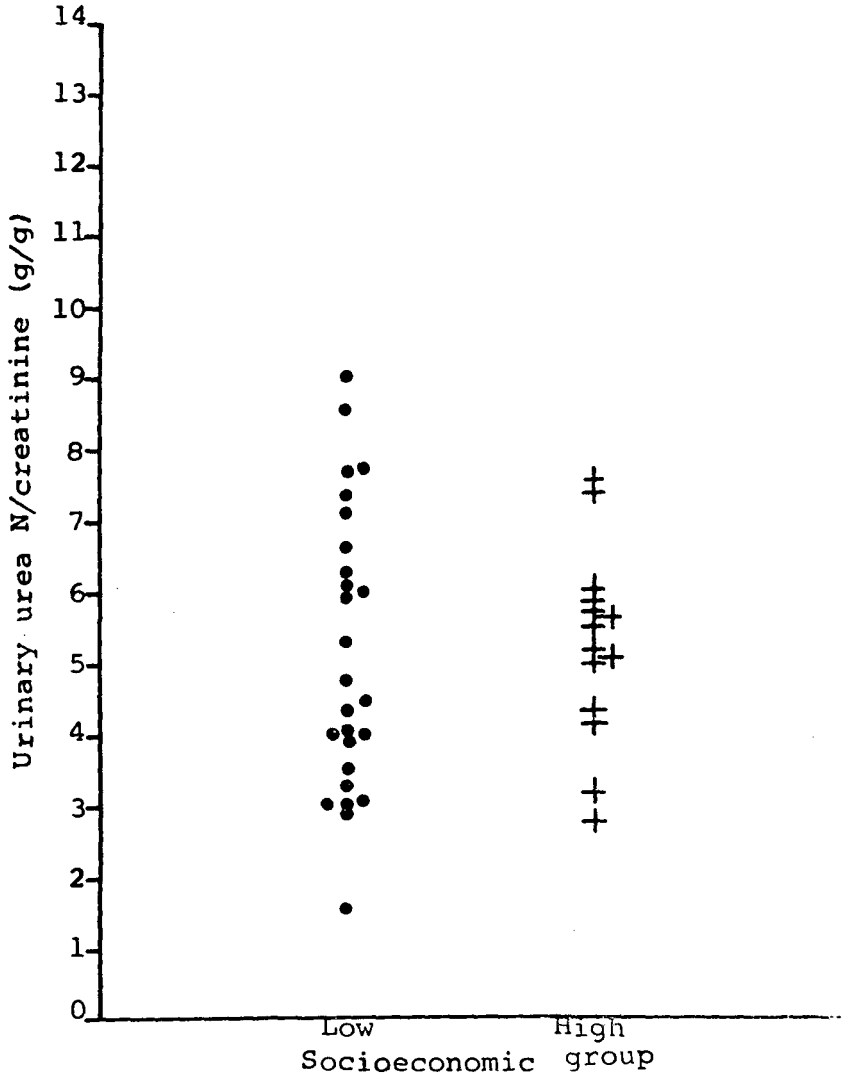


Fig. 2

Urea nitrogen/creatinine ratio in pregnant women of two socioeconomic groups in Guatemala.

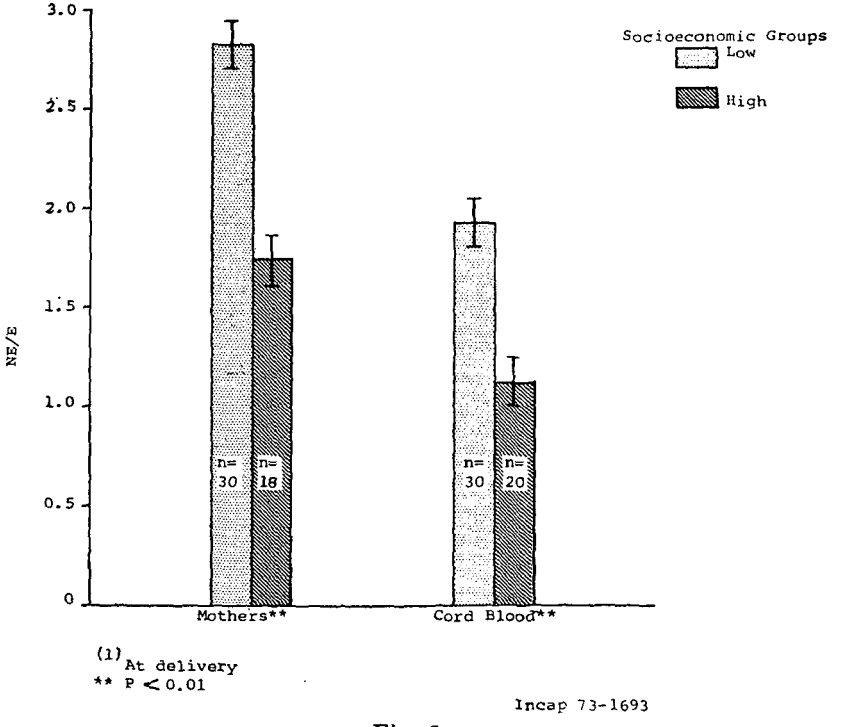


Fig. 3

Non-essential/essential serum amino acid ratio (NE/E) of pregnant women and cord blood in two socioeconomic groups.

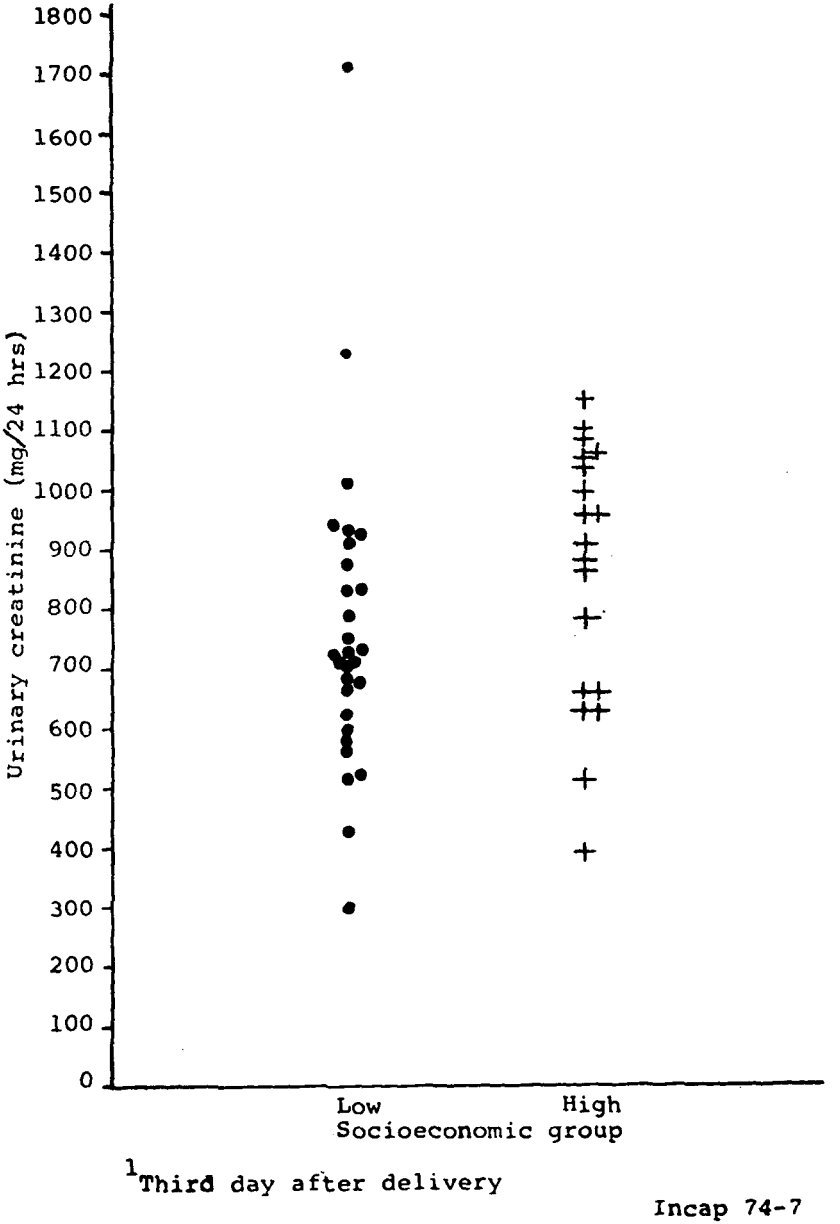


Fig. 4

Creatinine excretion in women of two socioeconomic groups in Guatemala.

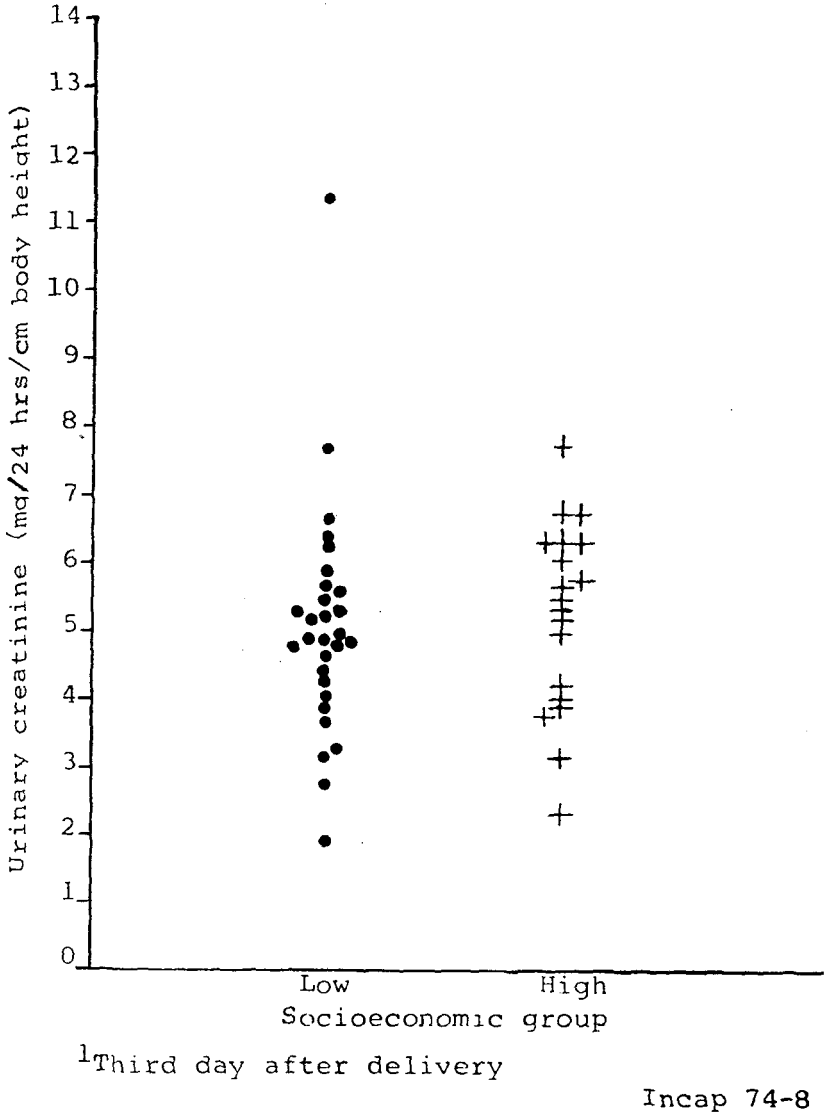


Fig. 5

Creatinine excretion per centimeter of body height in women of two *socioeconomic* groups in Guatemala.

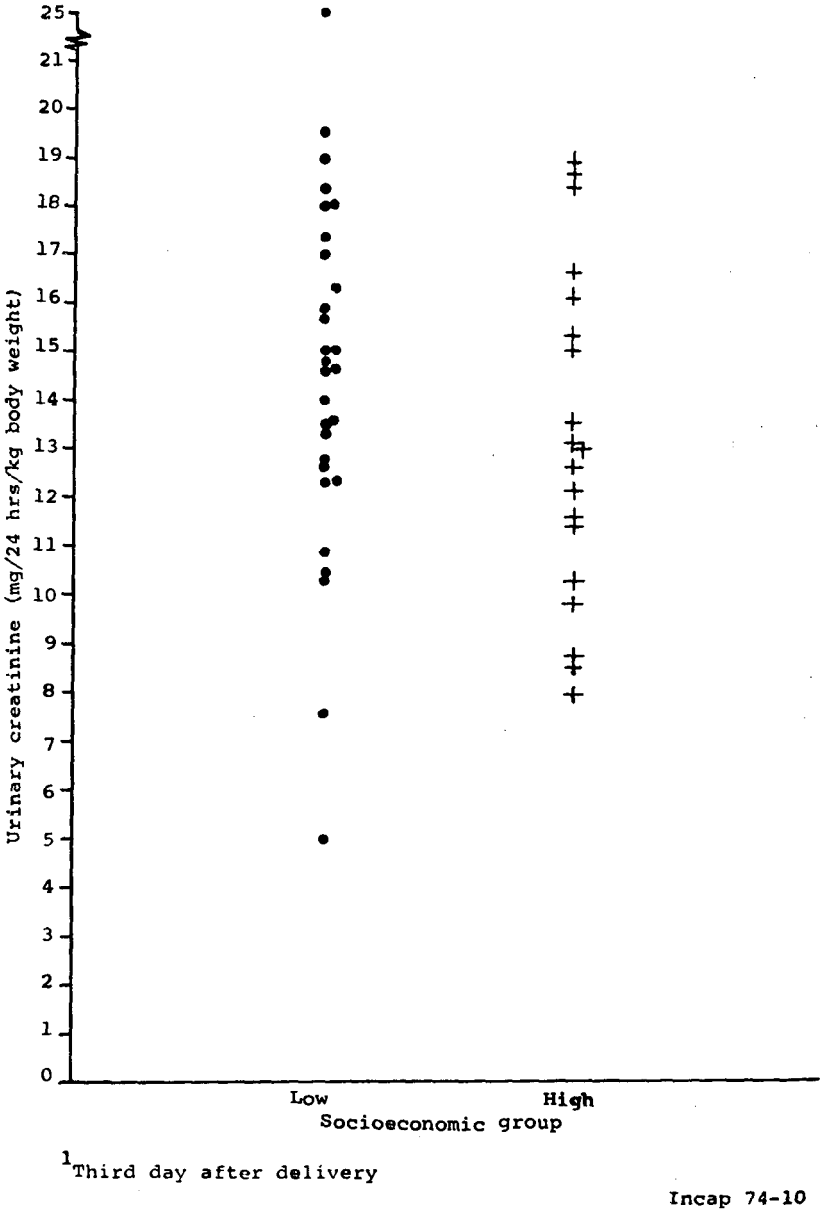


Fig. 6

Creatinine coefficient in women of two socioeconomic groups in Guatemala.

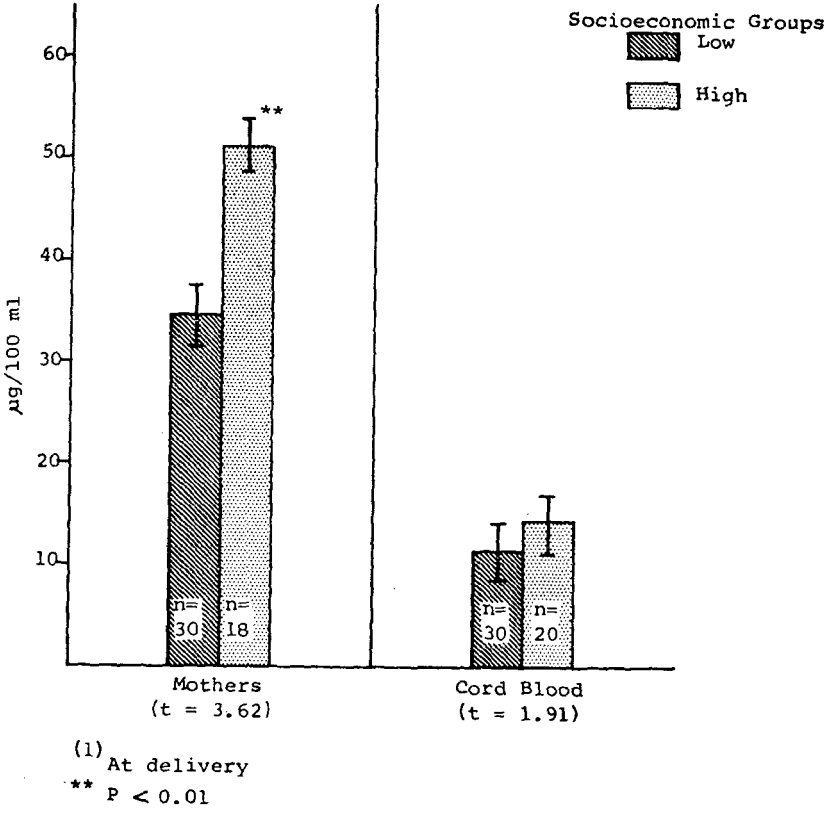
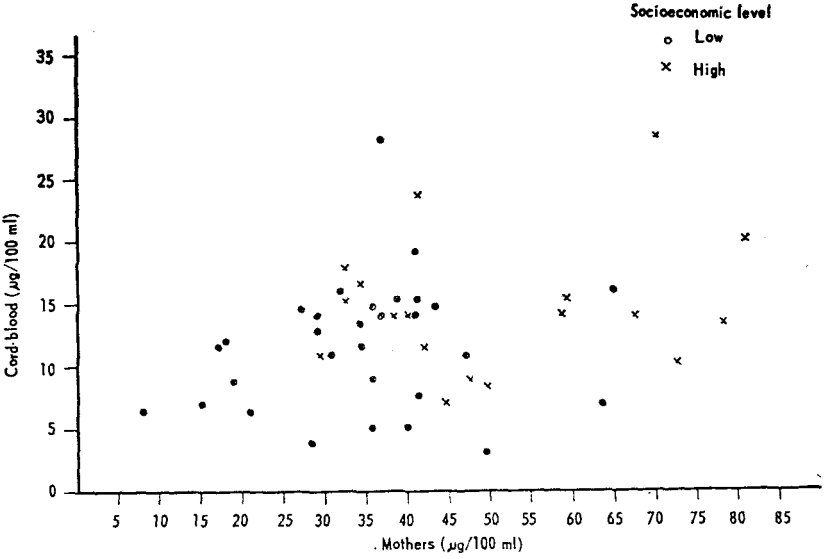


Fig. 7

Serum vitamin A in pregnant women and cord blood in two socioeconomic groups.



Number	Mothers Limits	Mothers $\bar{x}$	Cord-blood $\bar{x}$	Ratio Cord/mother (%)
11	0 - 29	22.2	9.8	41
28	30 - 49	39.2	13.0	33
9	50 - >	68.4	15.3	22

Incap 75-699

Fig. 8

Serum vitamin A in pregnant women and cord blood of two socioeconomic groups.

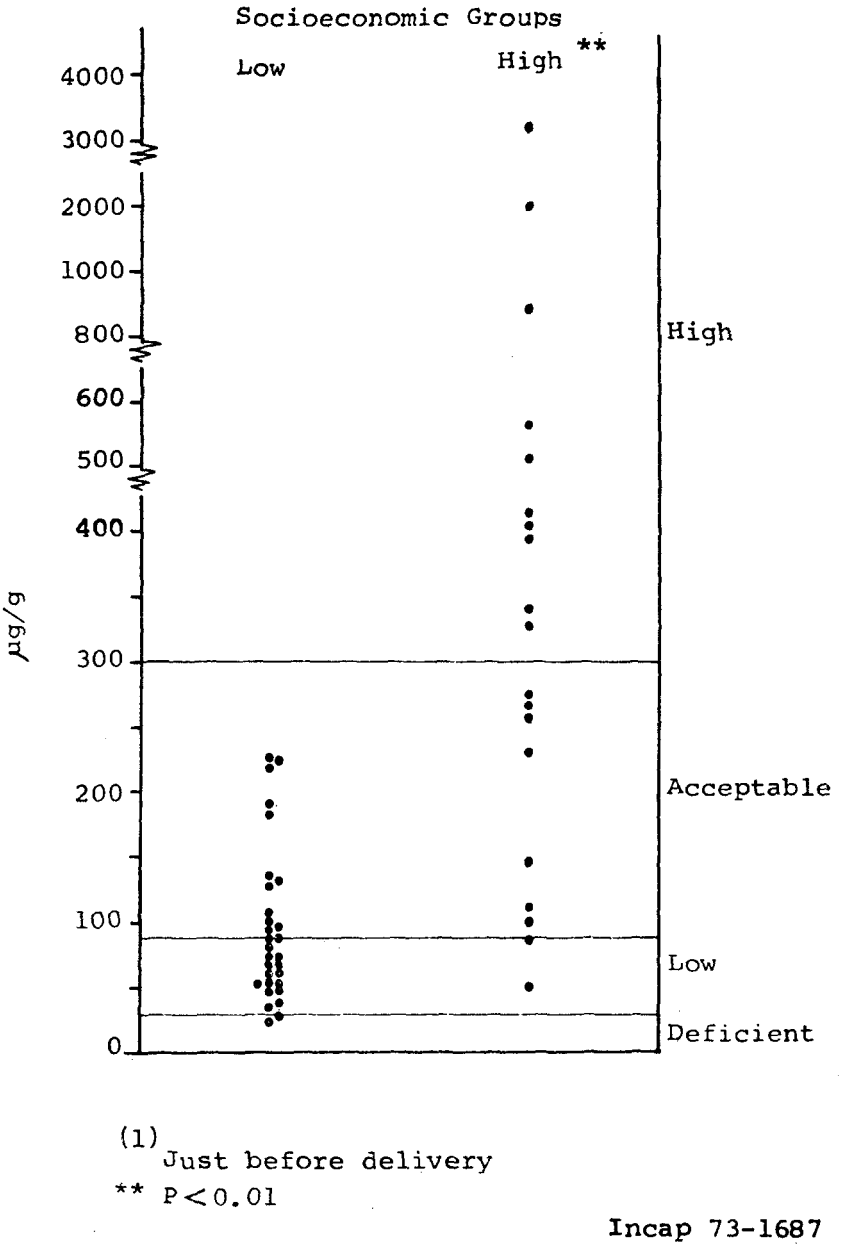
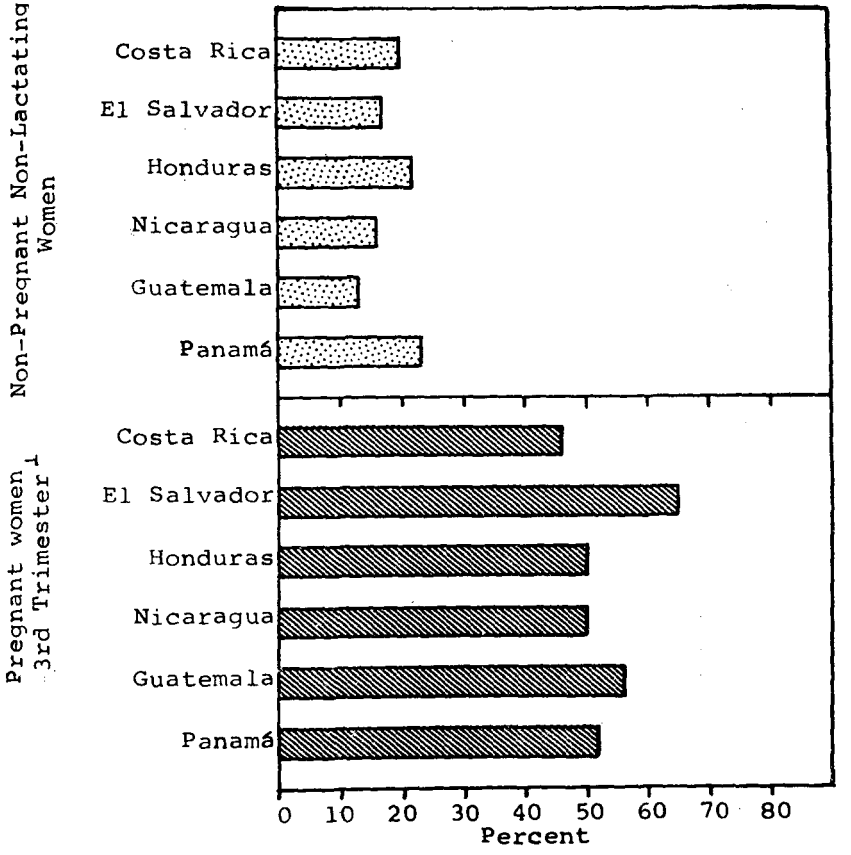


Fig. 9

Urine riboflavin of pregnant women of two socioeconomic groups.



1 Panamá second trimester of pregnancy

Incap 74-57

Fig. 10

Percent of pregnant women with deficient transferrin saturation (<15%), in Central America and Panama (1965-1966).

RESUMEN

NUTRICION DURANTE EL EMBARAZO
Estudios en Centro América y Panamá

La nutrición adecuada durante el embarazo es de gran importancia en salud pública, no sólo en función de la mujer misma, sino también por el impacto que ello pueda tener sobre el presente y futuro de su hijo. El estado fisiológico del embarazo representa mayores necesidades nutricionales, las que han sido estimadas por grupos de expertos que han dictaminado sobre nutrientes específicos, considerados en general independientemente unos de otros. El aumento porcentual en las recomendaciones para cada nutriente debido al embarazo varía de uno a otro en magnitud. Esto significaría que el patrón dietético recomendado para la mujer embarazada difiere notablemente de aquél establecido para la mujer no embarazada; esta observación, sin embargo, amerita mayor estudio y cuidadosa consideración.

En áreas como la de Centro América y Panamá donde prevalece la desnutrición, las mujeres embarazadas sufren de los mismos déficits nutricionales que la población general. Los principales déficits nutricionales en esta zona son los de energía, proteínas, vitamina A, riboflavina, hierro y folatos. En algunos casos, como en el de hierro y energía, los déficits parecen ser mayores en la mujer embarazada que en la población general. Los estudios comentados en este artículo arrojan evidencia de que los niños recién nacidos de madres desnutridas reflejan en algunos aspectos las alteraciones bioquímicas que se encuentran en la mujer embarazada.

BIBLIOGRAPHY

1. *Maternal Nutrition and Family Planning in the Americas.* Report of a PAHO Technical Group Meeting, Washington, D.C., 20-24 October 1969. Washington, D.C., Pan American Health Organization, 1970, 53 p. (PAHO Scientific Publication Nº 204).
2. *Recomendaciones Dietéticas Diarias para Centro América y Panamá.* Trabajo elaborado por M. T. Menchú, G. Arroyave y M. Flores, con asesoría de un grupo de profesionales del INCAP. Guatemala, C.A., INCAP, 1973, 33 p.
3. *Energy and Protein Requirements.* Report of a Joint FAO/WHO *Ad Hoc* Expert Committee. Geneva, World Health Organization, 1973, 118 p. (WHO Technical Report Series Nº 522; FAO, Nutrition Meetings Report Series Nº 52).
4. Beteta Mazariegos, C. E. *Embarazo y Nutrición. Estudio Longitudinal en Mujeres Embarazadas Pertenecientes al Grupo Rural de Bajo Nivel Socioeconómico de Guatemala.* Tesis de Graduación de Médico y Cirujano. Universidad de San Carlos de Guatemala, Facultad de Ciencias Médicas. Guatemala, C.A., noviembre de 1963. 99 p.
5. Flores, M., M. A. Guzmán, E. de León, L. de Gil & C. Canosa. Unpublished data.

6. Arroyave, G., W. H. Hicks, D. L. King, M. A. Guzmán, M. Flores & N. S. Scrimshaw. Comparación de algunos datos bioquímico-nutricionales obtenidos de mujeres embarazadas procedentes de dos niveles socio-económicos de Guatemala. *Rev. Col. Méd. (Guatemala), 11:* 80-87, 1960.

7. *Evaluación Nutricional de la Población de Centro América y Panamá. Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua y Panamá.* Instituto de Nutrición de Centro América y Panamá (INCAP); Oficina de Investigaciones Internacionales de los Institutos Nacionales de Salud (EEUU); Ministerios de Salud de los seis Países Miembros. Guatemala, Instituto de Nutrición de Centro América y Panamá, 1969. (6 volúmenes).

8. Arroyave, G., S. Valenzuela y A. Faillace. Investigación de deficiencia de riboflavina en mujeres embarazadas de la ciudad de Guatemala. *Rev. Col. Méd. (Guatemala), 9:* 7-13, 1958.

9. Beaton, G. H., G. Arroyave & M. Flores. Alterations in serum proteins during pregnancy and lactation in urban and rural populations in Guatemala. *Am. J. Cin. Nutr., 14:* 269-279, 1964.

10. Lechtig, A., M. Béhar, G. Arroyave, J.-P. Habicht, C. Yarbrough, F. Viteri, L. J. Mata, H. Delgado, J. Filer & R. E. Klein. Influence of maternal nutrition on the characteristics of the placenta and fetal growth. Presented at the *Symposium on Effects of Inadequate Nutrition on Human Development. Continental Meeting on Science and Man. México, D.F., June 20-July 4, 1973.* Sponsored by the Consejo Nacional de Ciencia y Tecnología (CONACYT) and The American Association for the Advancement of Science (AAAS), Washington, D.C.

11. Durán Vidaurre, E. y G. Arroyave. Estudio de la excreción urinaria de nitrógeno total, nitrógeno ureico y creatinina en niños bajo estados nutricionales diferentes. *Arch. Venezol. Nutr. (Caracas), 13:* 193-215, 1963.

12. Wang, Ch. Ch., J. E. Hawks, B. Huddlestun, A. A. Wood & E. A. Smith. The influence of high and low protein diet on the basal metabolism and the chemistry of blood and urine in normal women. *J. Nutrition, 3:* 79-98, 1930.

13. Spector, W. S. Ed. *Handbook of Biological Data.* Prepared under the direction of the Committee on the Handbook of Biological Data, Division of Biology and Agriculture, The National Academy of Sciences-The National Research Council. Philadelphia, W. B. Saunders Co., 1956, 584 p.

14. Viteri, F., M. Béhar, G. Arroyave & N. S. Scrimshaw. Clinical aspects of protein malnutrition. In: *Mammalian Protein Metabolism.* H. N. Munro and J. B. Allison (Eds.). Vol. 2 (Chapter 22). New York, Academic Press, Inc., 1964, p. 523-568.

15. U. S. Interdepartmental Committee on Nutrition for National Defense. *Manual for Nutrition Surveys.* 2nd ed. Washington, D.C., U.S. Government Printing Office, 1963, 327 p.

16. Horwitt, M. K., C. C. Harvey, O. W. Hills & E. Liebert. Correlation of urinary excretion of riboflavin with dietary intake and symptoms of ariboflavinosis. *J. Nutrition, 41:* 247-264,1950.

17. Viteri, F. E. Hematological status of the Central American population. Iron and folate deficiencies. Working document presented at the *XII Meeting of the Pan American Health Organization Advisory Committee on Medical Research, Washington, D.C., June 25-29, 1973.*