

# Effect of Low Nutrient Intake During Pregnancy on Obstetrical Performance and Offspring

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PREGNANCY demands increased nutrient intake, not only for the mother but also for the offspring. Numerous investigations have been made in the past in order to determine the correlation between the nutrient intake and nutritional status of pregnant women and of their offspring. It has also been suggested that pregnancy disorders and obstetric complications are seen more commonly among malnourished women. Data collected from various parts of the world during calamities, such as famine and war, usually support these views. For example, it was observed that obstetrical complications increased significantly during the Leningrad siege.<sup>1</sup> Similarly, during the war-time food shortage in Holland and other European countries, abortion and other obstetrical complications were commonly encountered; these were attributed to the food shortage and the resulting nutritional deficiency.<sup>2</sup> The data collected from these regions on the birth weight of the infants also showed a significant fall, presumably due to nutritional deficiency.

Antonov<sup>1</sup> reported that during siege conditions in Leningrad in 1942, when the average daily bread ration was 400 gm. and vitamin deficiencies rampant, the incidence of premature births rose from 6.5 to 41.2 per cent. Stillbirths were more than doubled in number, and the neonatal mortality rate was 90 per 1,000 for full term births and 308 per 1,000 for

premature births. Of the babies who were carried to term, a drop of more than 500 gm. in body weight was observed. Smith<sup>2</sup> reported that shortly after the hungry winter months of 1944 and 1945 when the diet of expectant mothers had reached a low point of about 1,145 calories and 34 gm. of protein a day, and they had associated deficiencies of vitamin A, niacin and riboflavin, 50 per cent of the women had amenorrhea. With the return to a better diet, menstruation started again. Birth weights had fallen but they rose after the liberation when more food became available. Balfour,<sup>3</sup> Ebbs and his colleagues,<sup>4</sup> the Peoples' League of Health and many others reported that supplementation of the diet of pregnant women resulted in a significant reduction in stillbirths, neonatal death, premature births and toxemia of pregnancy. These observations point up the necessity of supplementing the poor diet of pregnant women so that pregnancy disorders can be avoided and healthy offspring produced. This becomes more important in countries like India, where malnutrition is widely prevalent.

It must be admitted, however, that amenorrhea, pregnancy disorders and premature births can also be caused by psychological trauma, which is strongly operative during general calamities such as war and acute food shortage due to siege or famine. Therefore, the increase in the incidence of stillbirths, premature births, abortions and the low birth weight of the newborn cannot be explained entirely on the basis of nutritional deficiency. Other contributory factors in the environment must also be considered. Antonov<sup>1</sup> stated

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that in addition to the extreme shortage during the Leningrad siege, the housing was poor, the heating inadequate and in most cases the women performed hard manual labor during pregnancy. It is impossible, therefore, to separate the effects of malnutrition from those of the other adverse environmental factors. The improvement of these indices by nutrient supplementation in pregnancy, however, stands on a more rational basis. On the other hand, it might be expected that in countries where general malnutrition is prevalent and is not caused by an acute food shortage (as in war or famine), but by a state of chronic food shortage to which the population has generally adapted itself for years, the incidence of disorders in pregnancy will be significantly higher, and similarly the health of the offspring will be poorer. No such data are available from countries where a majority of the pregnant women subsist on diets in which the nutrient content is far below the recommended values. In fact, the general impressions of obstetricians is that the apparently healthy women in the lower economic strata perform extremely well during pregnancy, and natural spontaneous labor is more a rule than an exception. On the other hand, women from the upper economic strata, presumably consuming a diet adequate in nutrient content, more often require obstetrical interference during labor, which is usually prolonged and associated with complications. However, babies born to women in the upper economic strata are bigger and their birth weight is higher than babies born to women in the lower economic strata. It must also be remembered that the body stature of women belonging to the upper strata is usually larger; this is an important factor in determining the size and naturally the weight of the baby. The observation of Thomson<sup>5</sup>—that nutrition during childhood as reflected in body stature of the mother might be a more important factor than the nutritional intake during pregnancy itself—needs serious consideration.

In recent years, a number of investigations have been carried out in pregnant women. The findings suggest that certain metabolic adaptations take place in pregnancy as a result of which, possibly, the maternal organism can

carry on its activities with a much restricted intake of nutrients. Increased absorption of iron, some vitamins and increased retention of nitrogen are some examples of this adaptive phenomenon. Beaton,<sup>6</sup> in an excellent review of this important phenomenon, cites interesting evidences to prove the significance of the adaptive mechanism in pregnancy. Bose and Bagchi<sup>7</sup> followed up a group of pregnant and nonpregnant women of comparable age and socioeconomic level subsisting on a diet poor in calories, protein and minerals. Clinical and biochemical examinations revealed that despite the metabolic stress of pregnancy, the pregnant women had the same clinical and biochemical profiles as the nonpregnant women. It was surprising that except for some mild manifestations of riboflavin deficiency in the form of angular stomatitis and glossitis, which were also observed in the nonpregnant women, the pregnant women were fairly healthy. It was obvious that some form of nutritional adaptation occurring in pregnancy protects the women from the deleterious effect of an ill balanced diet. In the past it has been suggested that in human beings subsisting on a restricted intake of nutrients for a long time power of adaptation develops gradually. Adaptation of the human organism to a low calorie intake has already been suggested. Pathak<sup>8</sup> carried out an investigation on male and female beggars subsisting on a restricted diet and observed the relatively fair state of their nutritional status. There were twenty pregnant women in this group, but he makes no comment on their obstetrical performance.

It was considered worthwhile to study a number of pregnant women from the lower economic strata subsisting on a restricted intake of nutrients and to follow them up carefully, by clinical and biochemical means, throughout the entire period of pregnancy, to observe their obstetrical performance and to make an observation of the newborn infant.

#### EXPERIMENT

The investigation was conducted on 150 women from the low socioeconomic strata attending the antenatal clinics of Lohia Matri Seva Sadan, a maternity hospital. Clinical examinations were



TABLE I  
Details of the Subjects of This Investigation

Nutrient Intake	No.	Important Nutrient Deficiencies	Average Weight (lb.)	Economic Status (monthly income Rs. per head)	Profession
Deficient . . . .	150	Calories and protein	106	32	Housewife, 98%; professional women, 2%
Adequate . . . .	50	Nil	118	210	Housewife, 82%; professional women, 18%

TABLE II  
Daily Nutrient Intake of Pregnant Women in Different Economic Groups

Description of Subjects	Calories	Protein (gm.)	Fat (gm.)	Carbohydrates (gm.)	Calcium (gm.)	Iron (mg.)	Vitamin A (I.U.)	Thiamine (mg.)	Riboflavin (mg.)	Ascorbic Acid (mg.)
Pregnant women in higher economic strata . . . . .	2,760	86	52	472	1.3	27.6	4,600	2.6	2.4	72
Pregnant women in low economic strata . . . . .	1,920	48	29	331	0.51	18.5	2,120	0.74	0.33	21
Recommended values for pregnancy . . . . .	2,600	85	50	...	1.5	15	6,000	1.5	2.0	100

TABLE III  
Percentage Incidence of Different Nutritional Deficiencies

Description of Subjects	Total Investigated (no.)	Angular Stomatitis (%)	Glossitis (%)	Bleeding Gums (%)	Phryno-derma (%)	Cramps and Calf Tenderness (%)	Anemia* (%)
Pregnant women (third trimester) in higher economic strata . . . . .	50	2	3.5	4.5	Nil	2.5	46
Pregnant women (third trimester) in lower economic strata . . . . .	150	6	8	3	2	3	88

\*Hemoglobin level below 10 gm.

made at the hospital and blood samples drawn in the morning were obtained for biochemical analysis. Dietary data were first elicited by an oral questionnaire method and later checked by home visits. The subjects visited the hospital every fortnight for routine clinical check-ups and were then confined in the hospital. A careful record was kept of the history of confinement, the condition of the placenta and the newborn. The following records were carefully collected: dietary intake, nutritional status, body weight, serum protein and serum ascorbic acid level, maternal hemoglobin level, nature of confinement and duration of labor, cord blood ascorbic acid,

weight of placenta, weight and condition of infant, and infant hemoglobin level.

In order to obtain comparable values from subjects belonging to the high economic strata subsisting on a fairly adequate diet, similar data were collected from fifty pregnant women who were private patients and were confined in nursing homes. Table I gives the particulars of the subjects of this investigation.

The data about the dietary intake were obtained by questionnaire method, recommended by the Nutrition Advisory Committee of the Indian Coun-

TABLE IV  
Nature of Confinement and Other Allied Data in Different Economic Group

Description of Subject	Average Weight Before Confinement (lb.)	Subjects Requiring Obstetrical Interference (%)	Average Duration of Labor	Weight of Newborn (lb.)	Weight of Placenta (lb.)
<i>Pregnant Women in Low Economic Strata</i>					
Primigranda . . . . .	118	1	15 hr., 20 min.	6.22	1.08
2nd to 4th para . . . . .	121	Nil	12 hr., 15 min.	6.42	1.1
5th para and more . . . . .	126	Nil	12 hr., 36 min.	6.31	1.0
<i>Pregnant Women in High Economic Strata</i>					
Primigranda . . . . .	129	20	17 hr., 36 min.	6.76	1.1
2nd to 4th para . . . . .	136	12	15 hr., 10 min.	6.88	1.01

NOTE: Puerperium uncomplicated in all.

cil of Medical Research. To obtain more accurate information, measured utensils were shown to the subjects in order to help them to give reliable information concerning their food intake. Pasricha<sup>9</sup> has shown that, used judiciously, the information obtained by this method can be as reliable as that obtained by weighing the foodstuffs. Serum protein and its fractions were determined by the method of King and Wootton<sup>10</sup> based on biuret reaction. Serum ascorbic acid was determined by the colorimetric method of Roe and Kuether.<sup>11</sup> Hemoglobin was estimated by the standard method of Hellige.

#### RESULTS

The average daily intake of nutrients in the two groups are presented in Table II along with the values recommended by the Nutrition Advisory Committee of the Indian Council of Medical Research for pregnant women. On comparing the actual intake with the recommended values, it is apparent that the subjects belonging to the low economic strata consume a diet which is deficient in most of the nutrients, especially that of calories and proteins. On the other hand, the diet consumed by the women in the higher economic strata is adequate in almost all the nutrients, with minor deficiencies in some vitamins. In the case of protein, the average intake of the women in

the low economic strata was only 50 per cent of the recommended values. The deficiency of ascorbic acid is of a higher magnitude. It must also be remembered in this connection that all the values of nutrient intake are calculated on the basis of raw foods. The actual intake of vitamins, therefore, will be less than the stated values because of the destructive action of cooking processes.

The results of an assessment of nutritional status during the third trimester of pregnancy are presented in Table III. The different manifestations of nutritional deficiencies and the number of subjects showing these in the two groups do not differ much. Another interesting feature is the comparative absence of the manifestation of nutritional deficiencies in women in the low economic strata, considering the very low intake of nutrients.

In Table IV, the average weight of the subjects just before confinement, their parity, nature of confinement, duration of labor, weight of the placenta and the newborn are presented. Since the nature of confinement and duration of labor, to some extent, depend on the parity of the women, the subjects in the lower economic strata have been divided into three subgroups, according to their parity, and

TABLE V  
Biochemical Data on Mother and Infants

Description of Subjects	Maternal Serum Protein (gm. %, mean)	Maternal Whole Ascorbic Acid (mg. %, mean)	Cord Blood Ascorbic Acid (mg. %, mean)	Maternal Hemoglobin (gm. %, mean)	Infant Hemoglobin (gm. %, mean)
Pregnant women in low economic strata, 38th to 40th week . . . . .	6.1	1.04	2.87	9.7	17.2
Pregnant women in high economic strata, 38th to 40th week . . . . .	6.3	1.06	2.68	10.8	16.9

those in the higher economic strata into two. The number of women in the higher economic strata with obstetrical complications requiring "interference" is much greater than in the lower economic strata. In fact, of a total of 150 women from the lower economic strata, only two required interference, the remaining subjects were delivered in the normal manner. The reasons for obstetrical interference in the two economic groups are also of interest. The two cases in the low economic group which required interference were a case of prolapse cord and a brow presentation; whereas in the upper economic class the majority of cases were of uterine inertia. The duration of labor in women of different parities in the lower economic strata is consistently less than that observed in the women from the other group. Premature births or stillbirths were not observed in either group. There was no significant difference in the weight of the placenta between the two groups. All the infants were found to be healthy but the birth weight of those born to women in the lower economic strata was found to be 6.4 pounds as compared to 6.8 pounds in the higher economic strata. The higher body weight of the pregnant women in the latter group is also relevant in this connection.

In Table v the biochemical data obtained by analysis of blood from the mother and newborn are presented. The maternal blood was drawn during the thirty-eighth to fortieth week of pregnancy. It is interesting to note that the serum protein concentration of women in the low economic strata is 6.1 gm. per cent whereas in women in the high economic strata it is 6.3 gm. per cent. The difference between the two

groups is negligible although the former group was consuming 48 gm. of protein per day whereas the latter was receiving 86 gm. Similarly, the difference in the maternal blood ascorbic acid and the cord blood ascorbic acid levels, which reflects the state of saturation of the infants, is not significant in the two groups. The maternal hemoglobin level in women in the low economic strata is 9.6 gm. per cent on the average, whereas that in women in the high economic strata is 10.8. It is generally stated that due to hemodilution in pregnancy the hemoglobin level decreases but this does not indicate an actual reduction in concentration. Various workers, who have conducted investigations on this aspect, believe that a level of 10 gm. per cent can be regarded as normal and any value under that as indicating deficiency. In women in the low economic strata, the value is slightly under 10 gm. per cent and, on the basis of this, the majority of women can be classified as suffering from anemia, whereas in the majority of women in the higher economic strata the value is slightly above 10 gm. per cent, thus giving a completely different picture of nutritional anemia. The question of a marked type of hemodilution in women having a low intake of protein also has to be considered in this respect before drawing any conclusions. The hemoglobin level in infants in the two groups is more or less the same; it is also noteworthy that the hemoglobin level is comparable to that obtained by workers in infants born to women in the higher economic strata in different parts of the world.

#### COMMENTS

As mentioned earlier in this paper, the

present investigation was undertaken in order to determine how pregnant women living on an inadequate diet adapt themselves during this crucial phase of their life and how these adaptations, if at all, are reflected in their nutritional status, their obstetrical performance and on the health of the offspring. The result of this investigation, based on 150 pregnant women in the low socioeconomic strata and fifty women in the higher economic strata, show that the nutritional status of women during pregnancy and the condition of the offspring are not significantly different in the two groups. In this connection it must be mentioned that the women who were subsisting on the deficient diet during pregnancy had been accustomed to this type of diet since their birth. In fact, they were born, brought up, matured and then reproducing in a state of chronic moderate deficiency. The effect, therefore, is certainly different from that of an acute food shortage causing an acute deficiency as is usually seen when such calamities as famine, flood or war occur. It is possible that the human organism subsisting in a state of chronic deficiency might make metabolic changes in order to economize on whatever nutrients are available.

The findings of this investigation confirm that of Thomson<sup>5</sup> based on his studies in Aberdeen. He was unable to relate undernutrition to obstetrical performance. Thomson concluded: "The weight of evidence shows conclusively that the diets of pregnant women can vary widely, in quantity as well as in quality, without clinically obvious impairment of the reproductive processes." The nutrient intake of Thomson's subjects as well as those of many other investigators was not far below the recommended values. The result of the present investigation, therefore, is of considerable interest, since the dietary restriction is much more severe in these subjects, although of a chronic nature.

The results of all these investigations, however, do not minimize in any way the importance of nutrition in pregnancy. They only highlight the flexibility of the metabolic reactions in the human body. Pregnancy is a stress period in a human life. Moreover, the

role of the placenta, an organ especially created in pregnancy, in regulating the metabolism to a new gear, is not at all clear. Certainly, the large array of hormones and enzymes found in the placenta have many as yet undetermined functions to perform. Beaton<sup>12</sup> has questioned the validity of assuming that the pregnant woman remains unaltered in a nutritional sense, considering the fact that physiologically she is quite different from what she was before pregnancy. He further stated that the lack of effect of nutrition on pregnancy, except under extreme conditions, can be explained on the basis of a change in the metabolism of the nutrients or a nutritional adaptation.

Retention of protein in pregnancy as a result of metabolic alterations has been known for a long time.<sup>6,13</sup> Beaton<sup>12</sup> suggested that this retention appeared to be accomplished by a decreased excretion of protein, reflecting an increased economy of utilization. That these metabolic alterations are possibly due to hormonal control<sup>12</sup> are also known. All these investigations point to the nutritional adaptive mechanism in pregnant women to minimize the requirement of protein.

The physiological and nutritional adaptation in pregnant women as far as iron metabolism is concerned has been confirmed by several investigators. The subject has recently been reviewed by Hytten and Duncan.<sup>14</sup> There is general agreement, based on these investigations, that the efficiency of iron absorption is increased so that significantly increased amounts of iron can be absorbed during pregnancy without any increase in iron intake. Similarly, increased calcium absorption also has been reported in the later stages of pregnancy.<sup>15,16</sup> Considering the fact that the clinical manifestations of vitamin deficiencies are so rare in pregnant women living on a grossly inadequate diet, one might also presume that possibly the tissues resort to increased economy of utilization of the vitamins also.

The implications of these findings, and of those which are certain to come in the near future, will, to a large extent, explain the lack of correlation between the results of dietary



surveys and the nutritional status and obstetrical performance of pregnant women. Possibly, these might lead to a reorientation of our approach to the question of nutritional requirement in pregnancy.

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