NUTRITION — ITS PLACE IN OUR PRENATAL CARE PROGRAMS

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IN any consideration of prenatal nutrition, we might well attempt to answer these questions: (1) Does prenatal nutrition deserve a place of major importance in our public health and medical care programs? (2) Have we adequate proof that a program to improve the nutrition of women during pregnancy would result in marked benefits in child health and development and in maternal health? (3) If there is clearcut evidence in the affirmative, why does nutrition during pregnancy not occupy a more important place in our prenatal care programs?

Those of us who have been primarily interested in the problem of nutrition during the prenatal period find it difficult to understand why the medical profession has been so slow in its appreciation and acceptance of the importance of nutrition in prenatal care. Growth begins with conception, not with birth, but it is the pediatrician who first concerns himself primarily with the growth and development of the child—his work begins with the birth of the baby. The obstetrician is interested primarily in seeing that the mother goes through pregnancy, labor, delivery, and the postpartum period without undue hardship, and he has been accustomed to assume that if the course of her pregnancy is uncomplicated, the baby will in all probability be reasonably healthy. His interest in diet during pregnancy except insofar as it relates to excessive weight gain during that period and to the giving of concentrates such as iron, calcium, or vitamin D, has been slow to develop, because he has not been convinced that diet during pregnancy is of great importance to the health of the mother or to the health and development of the fetus.

Over a long period of years it has been repeatedly emphasized

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that pregnancy is a period of rapid growth and that the increased nutritional requirements of this period together with frequent impairment of the digestive system, especially in the early months, make careful attention to the diet of the mother doubly important. There are frequent examples of the fact that the increased requirements of this period superimposed upon a mild deficiency (due to what we may term a suboptimal normal dietary intake) result in frank deficiency symptoms in the mother. It is possible to review the literature and find many illustrations of fetal damage resulting from prenatal dietary deficiency of various types. Not only is this true in animal experimentation, such as the work of Dr. Warkany and his associates (1), but there is a surprising amount of evidence of damage to the human fetus also due to inadequate maternal nutrition. It is, however, only within the last few years that interest in the science of nutrition has developed to a point where there have been collected data as to what women actually consumed during pregnancy and these nutritional findings evaluated in relation to the mother's condition during pregnancy, labor, delivery, and the postpartum period and to the condition of the infant at birth. The work of Ebbs, Tisdall, and Scott (2), for example, is an important contribution in this field and has done much to stimulate the interest of the medical profession in this important phase of nutrition.

As a part of the research program on the growth and development of the well child undertaken by the Department of Child Hygiene of the Harvard School of Public Health, a study of the influence of diet during pregnancy upon fetal growth and development as well as upon the course of pregnancy, labor, delivery, and puerperium has been made. Data have been collected on 324 women and their infants. The published data are on 216 women and their infants, in each case the oldest sibling of that family in the study. The women were drawn from the prenatal clinics of the Boston Lying-in Hospital. Approximately 90 per cent of the parents of these children are of Northern European stock and from an economic standpoint

represent the average "middle class" family. The majority of the women were between 20 and 30 years of age and 60 to 70 per cent were primiparae. These women were examined periodically during pregnancy, labor, delivery, and postpartum period by the obstetricians attached to the hospital staff; those in charge of this phase of the study were also members of the research staff. Detailed nutrition histories were obtained at regular intervals. These were supplemented by food records which the women kept. The diets were evaluated in relation to a set of nutritional standards which approximate the values later recommended by the Food and Nutrition Board of the National Research Council (Table 1). Each nutritional essential was rated on the basis of the woman's average daily consumption as "excellent," "good," "fair," "poor," or "very poor"—each rating representing a numerical range in relation to the standard which was called "excellent." The obstetrician and, within forty-eight hours of birth, a pediatrician from the study examined each infant and evaluated his physical condition. Infants whose

Table 1. Optimal daily nutritional requirements in pregnancy and the optimal normal requirements of the average woman.[1]

Nutritional Essentials	Normal	Pregnancy[2] (4th Through 9th Month)
Calories[3]	2,200-2,400	2,600-2,800
Protein, Gm.	60	85-100
Calcium, Gm.	0.8	1.5
Phosphorus, Gm.	1.32	2.0
Iron, Mg.	15	20
Vitamin A,[4] I.U.	5,000	8,000
Thiamin, Mg.	1.5	2.0
Riboflavin, Mg.	2.0	2.5
Niacin, Mg.	15	18
Ascorbic acid, Mg.	70	100
Vitamin D, I.U.		400-800

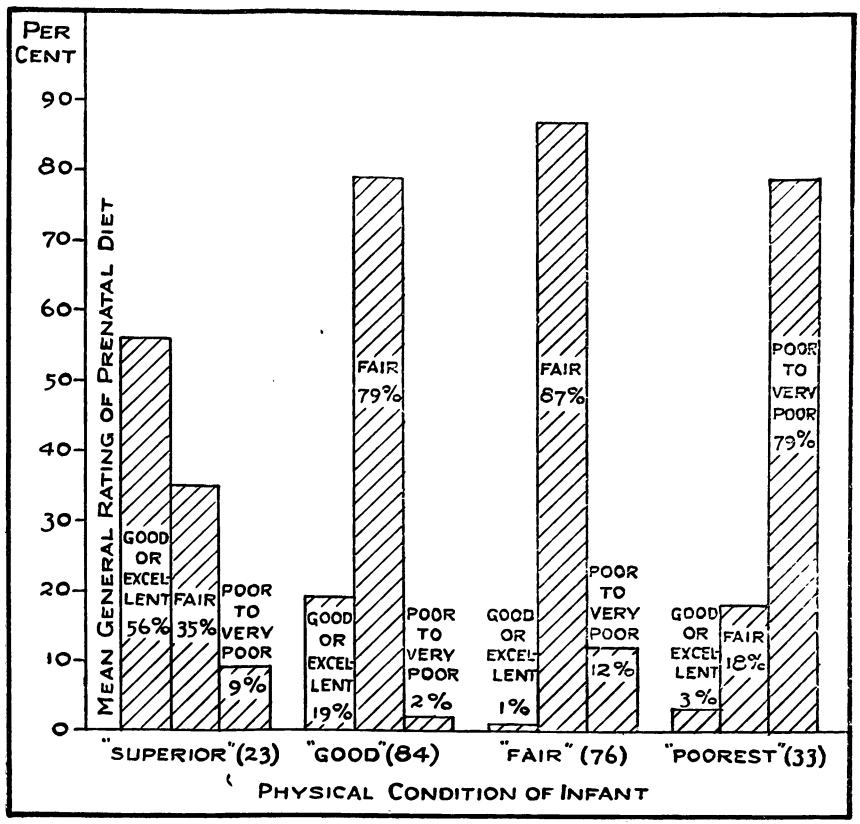
Courtesy of *American Journal of Obstetrics and Gynecology*. 46, July 1943.

[1] Generally accepted optimal nutritional requirements, according to available data.
[2] Assuming the changes in the first trimester to be so small as to be negligible.
[3] Energy requirements vary with activity, size of the individual, etc.
[4] The requirement for vitamin A may be less when provided as vitamin A and may be more if provided chiefly in the form of carotene.

neonatal course was unsatisfactory were seen frequently by the pediatrician, who also examined each infant again before discharge from the hospital. The pediatric ratings describing the condition of the infants at birth and within the first two weeks after birth are based upon these data.

Of the 216 women studied only 14 per cent consumed a diet which could be rated excellent or good according to these nutritional standards, 69 per cent had fair diets (23 per cent of these were fair to poor), and 17 per cent had diets which were poor to very poor. This means that approximately 40 per cent of these women were definitely malnourished according to these standards during a period when the fetus undergoes very rapid growth and development and that many more had only a mediocre diet during this very important growth period.

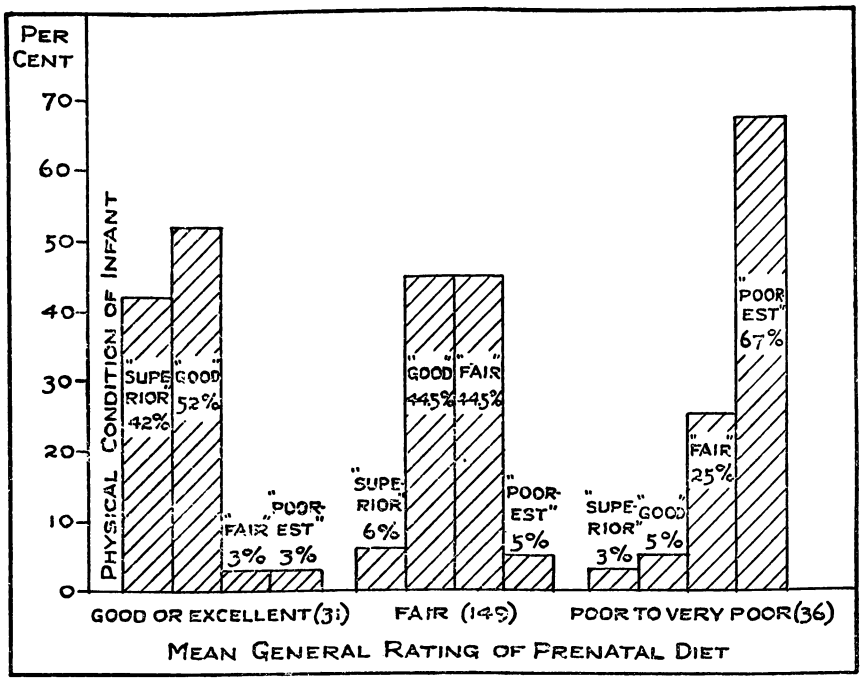
In considering the findings, you should remember that the ratings in each field, pediatric, obstetric, nutritional, anthropometric, etc., have been made independently on all mothers and their infants by the person in charge of the particular field, and the results assembled to determine possible associations of statistical significance. Considering the effect which prenatal nutrition may have on infant morbidity and mortality, the general dietary rating during pregnancy was studied in relation to the infant's condition at birth and within the first two weeks after birth. For ease of comparison those infants whose condition was called good or excellent and against whom there was no physical count of any kind at birth and during the first two weeks after birth were called "superior." There were twenty-three such infants (Figure 1). Fifty-six per cent of the mothers of these infants had a "good" or "excellent" diet during pregnancy, 35 per cent a "fair" diet, and only 9 per cent a "poor to very poor" diet. In contrast if the "poorest" infants, of whom there were thirty-three, are considered, i.e. those who were stillborn or who died within a few hours or days of birth, had a marked congenital malformation at birth, were premature or "functionally im-



Courtesy of *The Journal of Nutrition*, 26, No. 6, December, 1943.

Fig. 1. Relationship of the condition of infant at birth and within first two weeks of life to mother's diet during pregnancy. (Cases selected on the basis of pediatric ratings of infants, 216 cases.)

mature," it is found that 79 per cent of these prenatal diets were "poor to very poor," 18 per cent "fair," and only 3 per cent "good" or "excellent." Realizing that there were more "good" or "excellent" prenatal diets than infants who could be classified as "superior" and more "poor to very poor" diets than "poorest" infants, the cases were sorted on the basis of the mother's dietary rating for pregnancy (Figure 2). It was found that when the mother's diet was "good" or "excellent" (thirty-one cases) 42 per cent of the infants were "superior," and only one child (3 per cent) fell into the "poorest" classification because of a congenital defect; 55 per cent received

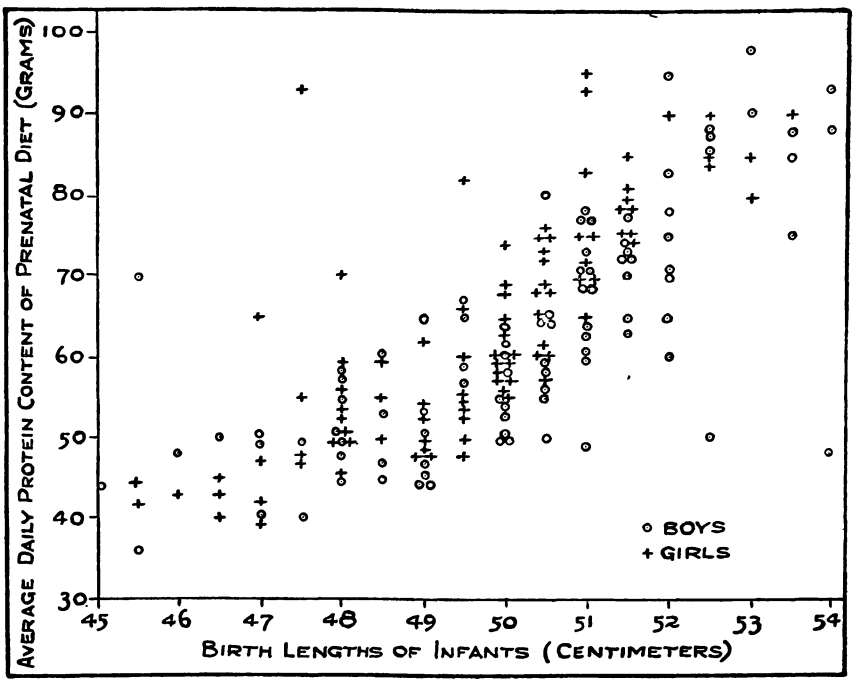


Courtesy of *The Journal of Nutrition*, 26, No. 6, December, 1943.

Fig. 2. Relationship of prenatal nutrition to the physical condition of the infant at birth and within first two weeks of life. (Cases selected on the basis of mean rating assigned to mothers' diets during pregnancy, 216 cases.)

pediatric ratings between these two extremes and the majority of these cases had only one, occasionally two, physical counts against them, largely minor in nature. In all cases where these physical counts were considered minor the infant was said to be in "good" physical condition. All infants who did not fall into one of these three carefully defined classifications were called "fair." In contrast, of the infants (thirty-six) whose mother's diets were "poor to very poor" only one infant (3 per cent) was "superior," while 67 per cent were in the "poorest" classification and 25 per cent were only "fair."

One hundred and sixty of the infants fell between the pediatric ratings "superior" and "poorest." Sorting these cases into the two now defined classifications of "good" and "fair" this middle group of 160 infants was divided into eighty-four "good" infants and



Courtesy of *The Journal of Pediatrics*, 23, No. 5, November, 1943.

Fig. 3.

seventy-six "fair" infants (Figure 1). In the case of the "good" infants 19 per cent of the prenatal diets were rated as "good" or "excellent," 79 per cent "fair," and 2 per cent "poor to very poor," while of the infants in "fair" physical condition only 1 per cent of the prenatal diets were "good" or "excellent," 87 per cent were "fair," and 12 per cent "poor to very poor." If the 149 "fair" diets serve as the basis of classification (Figure 2), it is found that 44.5 per cent of these infants were "good" and an equal number fall into the "fair" classification, only 6 per cent were "superior" and 5 per cent were classified as "poorest." The average birth weight of the "superior" infants was 8 pounds, 2 ounces and the birth length 50.8 cm., while in the case of the "poorest" infants the average birth weight was 5 pounds, 15 ounces and the length 47.2 cm. When selected on the basis of the prenatal dietary ratings the average birth weight of those infants whose mothers' diets were considered

"good" or "excellent" was 8 pounds, 8 ounces, length 51.8 cm., in contrast to 5 pounds, 13 ounces and 47.2 cm. in the case of those infants whose mothers' diets were "poor to very poor."

In analyzing the prenatal diets I was amazed at the number of women whose diets were poorly supplied with protein during this important growth period. Only 10 per cent of the 216 women had diets which could be considered "excellent" in protein (85 gms. or more per day), while 70 per cent consumed diets which were "fair" (55 to 69 gms.) or below in this important nutrient and 14 per cent ate less than 45 gms. daily. A significant relationship was found between the protein content of the mother's diet during pregnancy and the birth length of her infant (Figure 3). This increase in birth length can be demonstrated with each 10 gm. increment of protein in the mother's diet irrespective of the mother's height. An increase in birth weight was also demonstrated with each 10 gm. increment of protein in the prenatal diet (Table 2). The amount of protein in the diet during pregnancy seems to be a significant factor in the

Table 2. Relationship of birth weight[1] and birth length to total protein in mother's diet during pregnancy (fourth through ninth month).

	Average Total Protein (Gm.)					
	Under 45	45 to 54	55 to 64	65 to 74	75 to 84	85 or More
	Birth weight in pounds and ounces					
Boys	6,8	7,0	7,7	8,0	8,5	9,2
Girls	5,14	6,14	7,8	7,12	8,1	8,8
	Birth length in centimeters					
Boys	47.6	49.3	50.2	51.4	52.0	53.3
Girls	46.8	48.7	49.9	50.3	51.4	52.4

Courtesy of *Journal of Pediatrics*, 23, November 1943.

[1] No infants under 5 pounds in weight were included in this distribution.

determination of an infant's birth length and birth weight. Since it has already been shown that these are related to the physical rating of the infant, the amount of protein in the mother's diet during pregnancy would appear to be an important factor in determining the general physical condition of the infant at birth (Table 3). From a practical standpoint these results indicate that less than 75 gms. of protein daily during the latter part of pregnancy result in an infant who will tend to be short, light in weight, and most likely to receive a low pediatric rating in other respects.

While a statistically significant relation was also found between the mother's dietary rating and the course of her pregnancy this relationship was not as marked as that existing between the prenatal dietary rating and the condition of the infant. Sixty-eight per cent of the women having a "good" or "excellent" diet during pregnancy

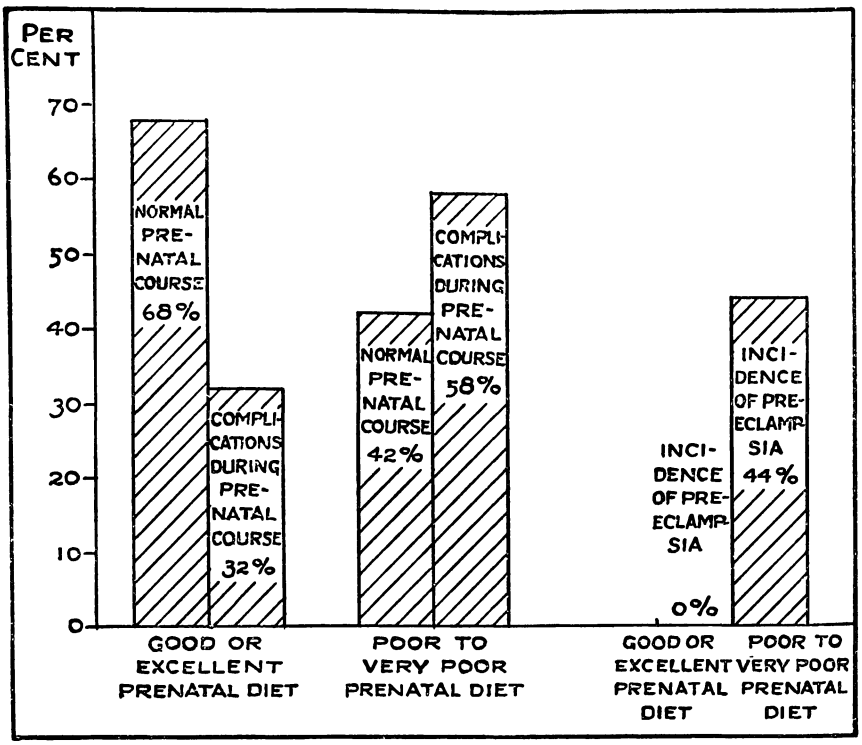
Table 3. Relation of birth lengths and birth weights to pediatric ratings assigned to infants at birth and within the first two weeks of life.

	Norm[1]	Pediatric Ratings[2]			
		"Superior"	"Good"	"Fair"	"Poorest"
	MEAN WEIGHT IN POUNDS AND OUNCES				
Boys	7,10	8,6	8,0	7,4	6,11
Girls	7,8	7,15	7,12	7,1	6,15
	MEAN LENGTH IN CENTIMETERS				
Boys	50.6	51.5	51.1	49.9	49.1
Girls	50.1	50.8	50.2	49.2	49.4

Courtesy of *Journal of Pediatrics*, 23, November 1943.

[1] Vickers, V. S. and Stuart, H. C.: Journal of Pediatrics, 22, 1943, 155.

[2] The pediatric rating "superior" refers to all of the infants in the group of 216 against whom there was no physical count of any kind at birth, or within the first two weeks of life. "Good" includes all infants in the group who were considered in good condition, except for one or two minor physical counts. "Poorest" includes all infants who were stillborn, died within a few hours or days of life, had a marked congenital defect, were premature, or "functionally immature," except that in this table we have excluded those who were premature (weight under 5 pounds). All infants not in one of these three classifications have been termed "fair" (within this group are some infants who were in the "fair to good" range and others in the "fair to poor" range in physical condition).



Courtesy of *American Journal of Obstetrics and Gynecology*, 46, July, 1943.

Fig. 4. Relationship of the prenatal course to the mother's diet during pregnancy. Incidence of pre-eclampsia in relation to the mother's diet during pregnancy. Of the women (31) whose diets during pregnancy were "excellent" or "good," 21 had a normal prenatal course, 10 had complications, such as severe nausea (4), rheumatic heart disease (no failure, 1), marked anemia (1), severe epidermophytosis of hands (1), duodenal ulcer (1), edema (1), staining, (1). Of the women (36) whose diets during pregnancy were "poor to very poor" 15 had a normal prenatal course, 21 had complications as follows: pre-eclampsia (16), (9 had other complications as well); pernicious vomiting and severe anemia (1); marked anemia (3); and staining (1).

experienced a normal course, while only 42 per cent of the women with a "poor to very poor" diet had a normal pregnancy (Figure 4). This would indicate that with an inadequate prenatal diet the fetus may suffer to a greater degree than the mother. In other words the fetus is parasitic upon the mother only to a certain extent and that extent is limited apparently by the mother's nutritional state at the time she enters pregnancy and by the quality and quantity of her diet. It is very important to realize this fact, because in the usual

clinical examination during pregnancy it is not possible to evaluate adequately the condition of the fetus, and it is entirely possible that a woman may have an apparently normal clinical course, but if she is consuming an inadequate diet, the fetus will in all probability suffer. Contrary to the usual obstetric teaching, the health of the fetus is greatly dependent on the mother's nutrition during pregnancy. An interesting and highly significant relationship was found to exist between the mother's general dietary rating and the incidence of toxemia during pregnancy. While the incidence where the diets were rated "good" or "excellent" was zero, among the women whose diets were "poor to very poor" it was 44 per cent, and among those whose diets were "fair" 8 per cent (Figure 4).

Another interesting finding is that while the average hours of labor of all the primiparae whether their diets were rated "good" or "excellent" or "poor to very poor" were approximately the same (14 hours); those women whose diets were called "poor to very poor" experienced many more difficult types of delivery, all this in spite of the fact that the average birth weight of these infants was almost three pounds less than that of infants born to mothers whose diets during pregnancy were rated "good" or "excellent."

A study is at present being made of possible relationships between the woman's preconceptional weight, her weight gain during pregnancy, her weight at approximately two weeks postpartum, the infant's birth weight, and the mother's diet during pregnancy. While it is not possible to discuss these findings in detail at this time, it is apparent that our thinking in these respects has not been clear. Using Metropolitan Life Insurance figures as a basis for deciding a given individual's normal weight for height and age and calling +five pounds to –ten pounds of this weight "normal," 32 per cent of these women were found to be underweight against 24 per cent who were overweight when they entered pregnancy. In studying the weight gain during pregnancy in relationship to weight change (the difference between the preconceptional and the post-

partum weights) the underweight woman who gained during pregnancy approximately the same or more than the normal or overweight woman, gained more weight herself in relation to her preconceptional weight and gave birth to a smaller infant. The very overweight woman eating inadequate calories lost weight herself to a considerable degree but had a larger baby than the woman with adequate calories who was normal or underweight. Here again, apparently, is evidence that the fetus is parasitic upon the mother only to a degree and that we need to pay much more attention to the woman who enters pregnancy below ideal weight; if our figures are correct, she apparently needs to be allowed to gain in the neighborhood of twenty-four pounds above whatever is her ideal weight, otherwise "nature" will tend to protect her at the expense of her infant.

It would seem that we are justified in concluding that the prenatal period is an important period in life where effective and intelligent nutrition teaching would result in great gains to national health. It would be expected to result in lowered infant mortality and morbidity, especially in the neonatal period; it would bring about marked improvements in child health and development, and also in improved maternal health and mortality.

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