# THE INFLUENCE OF PRENATAL DIET ON THE MOTHER AND CHILD[1]

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DURING the past twenty-five years, the number of deaths in infants under one year of age has been markedly reduced. The number of deaths in the first few weeks of life, however, has been altered very little. Apart from congenital abnormalities, birth trauma and prematurity, there still remain a number of unexplainable deaths. This study was undertaken in order to determine the effect of poor and good prenatal diets upon the outcome of pregnancy and condition of infant during first months of life. Only patients who had not reached the end of the sixth month of pregnancy and those patients who signified their intention of being confined in the Toronto General Hospital were included in the study. If any major disease was found that patient was excluded.

Briefly, the method of study was as follows: (1) An analysis of the patient's food record was made at the beginning of observation; (2) this analysis was repeated two months later; (3) patients were classified into three groups, namely, those receiving a poor diet throughout, or having a supplemented diet, or subsisting on a good diet and receiving advice; (4) blood examinations were made for hemoglobin, vitamin C, and phosphatase; (5) obstetrical rating was given each patient for (a) the prenatal period, during labor and convalescence, and with respect to (b) condition of baby at birth, (c) follow-up examination of the mother, (d) ability of mother to nurse infant, and (e) the whole course of pregnancy from beginning to end of observation; (6) babies were examined at six months and at twelve months of age, and records were kept of illnesses, general condition, and eruption of teeth.

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Each patient at the first interview was given a record form containing a space for each meal for seven days. In this she was instructed to write down the kind and amount of each food eaten at each meal for seven days. She was instructed to record weights of food, where possible; otherwise, to record in common measures, such as tablespoonful, cupful, ounces, or measure of solid foods in inches, or as large, medium, or small vegetable or fruit. The patient then returned with this record and was interviewed by the dietitian. Each detail on the record was checked by means of questioning and comparison with amounts bought and amounts served at each meal to the whole family. Recipes were also discussed and methods of cooking. Social workers visited the homes of many of the patients in the Supplemented Group in order to check the consumption of the foods being sent. A trained worker visited the home of a small number of patients in each group and weighed the food after it had been estimated and recorded. Having arrived at the approximate amounts consumed, the foods were then totalled for the week under the following headings: eggs, meat (to include fish and fowl), milk, cheese, cream, butter, oil, bread (white and brown), cereals, potatoes, vegetables (cooked and raw), fruits (citrus and others), sugar, and miscellaneous. This list formed the basis for scoring the diet as "good," "fair," or "poor." A consultation was then held and with this diet record, knowledge of the family income, rent, and number of dependents, each patient was considered for further study.

If the diet was poor and the income low, each alternate patient was selected for help from a special fund.[3] Those who did not receive help were left on their poor diets, were given no dietary advice, and will be referred to as the Poor Diet Group. There were 120 in this group. Those who had been on an equally poor diet until the fourth or fifth month of pregnancy and then received extra food from us, will be referred to as the Supplemented-to-Good

[3] This fund was provided by a Toronto business man.

| | | | |
|---|---|---|---|
| | | *Vitamins:* | |
| Calories | — 2,400–2,800 | A | — 6,000 I.U.[1] |
| Protein | — 80–100 gm. | $B_1$ | — 500–1,000 I.U. |
| Fat | — 80–100 gm. | $B_2$ | — 3.0–3.5 mg. |
| Carbohydrate | — 350–400 gm. | C | — 50–75 mg. |
| Calcium | — 1.5 gm. | D | — 500–1,000 I.U. |
| Iron | — 0.020 gm. | | |
| Iodine | — In iodized salt | [1] International Units. | |

Table 1. Nutritive factors yielded by the recommended Good Diet used in this study.

Diet Group. There were ninety of these. It was found that approximately one-half of the patients in the clinic were on moderately good diets and had sufficient income to provide a good diet if given advice. Advice in detail was then given. These will be referred to as the Good Diet Group. There were 170 of these studied.

As a basis for planning reasonable food requirements during pregnancy, we aimed at the following amounts of the essential foods: daily, 40 ounces of milk, 1 ounce cheese, 1 egg, an average serving of butter and meat, 2 servings of vegetables in addition to potato, 1 orange or one-half grapefruit or 5 ounces of tomato juice, one-half of the cereals and bread consumed to be in whole grain form, 2 teaspoonfuls of cod liver oil or equivalent in concentrate, liver once a week, salt to be iodized, and medicinal iron to be used if indicated. Two tablespoonfuls of wheat germ daily were advised. The constitution of such an average diet is given in Table 1.

We advised those patients with sufficient income in the Good Diet Group to try to obtain the amounts given in Table 1.

To the patients in the Supplemented-to-Good Group we sent daily, 30 ounces of milk, 1 egg, and 1 orange. Once a week, we also sent two 16-ounce tins of factory canned tomatoes and one-half pound of cheddar cheese. At the clinic we distributed a palatable dried wheat germ which contained malt, and added iron.[4] Two tablespoonfuls contained 12 mg. of iron. Viosterol capsules containing 2,000 International units of vitamin D were supplied, with

[4] Embryon—Scientific Foods, Ltd., Toronto.

instructions to take one daily.[5] Advice in detail was given to the women in this group regarding the use of this extra food, and instruction was given in planning the remainder of the diet from the family income.

The average cost of the extra food supplied to the ninety women in the Supplemented-to-Good Diet Group for an average period of 4.7 months was $25.00 per patient.

In order to offset any possible psychological factor due to the taking of medicine, patients not receiving supplemental food were given gelatin capsules resembling the viosterol capsules, but containing instead plain corn oil.

The additional food supplied to the patients in the Supplemented-to-Good Group gave the following daily average values: protein, 45 gm.; fat, 46 gm.; carbohydrate, 60 gm.; calories, 840; calcium, 1.45 gm.; iron, 15 mg.; vitamin C, 50-80 mg.; vitamin $B_1$, 350-400 I. U., and vitamin D, 2,000 I.U.

In order to eliminate errors in judgment and to offset the number of dietitians interviewing the patients, each diet record was later calculated for protein, fat, carbohydrate, calories, calcium, and iron.[6] The material was arranged in such a form that information regarding the vitamin content could also be calculated.

In Table 2, it will be noted that the Poor Diet Group and the Supplemented Group were equally low in every respect in the first record made at the beginning of the observation. The average figures of the diets of patients in the Good Diet Group are moderately good. In the second record, made about four or six weeks before confinement, the average of the diets in the Poor Diet Group is still low, although slightly increased over the first record. It will be noted that the figures in the Supplemented Group and the Good Diet Group have improved markedly, the former by supplying food, and the latter by education.

[5] Kindly supplied by Mead Johnson & Company.

[6] Figures for calculation of protein, fat, carbohydrate, calories, calcium, and iron were chosen mainly from Table 13 of APPLIED DIETETICS by Francis Stern.

| | | Protein Gm. | Fat Gm. | Ch Gm. | Cals. | Ca Gm. | Fe Mg. |
|---|---|---|---|---|---|---|---|
| First Record | Poor Diet | 56 | 66 | 213 | 1,672 | .537 | 10.7 |
| | Supplemented—Good Diet | 56 | 67 | 212 | 1,690 | .562 | 10.5 |
| | Good Diet | 81 | 95 | 261 | 2,206 | .886 | 14.2 |
| Second Record | Poor Diet | 62 | 75 | 232 | 1,837 | .746 | 11.6 |
| | Supplemented—Good Diet | 94 | 111 | 283 | 2,424 | 1.61 | 24.3 |
| | Good Diet | 92 | 113 | 293 | 2,521 | 1.30 | 18.3 |

[1] All figures are per diem.

Table 2. Analysis of diets in pregnancy.[1]

Table 3 shows the percentage of patients in each group on the basis of their protein intake. The improvement in the Supplemented and the Good Diet Groups will be noted. Sixty per cent of the patients in the Poor Diet Group were taking less than 60 gm. of protein daily. Seventy-eight per cent in the Supplemented Group were getting more than 80 gm. daily after the extra food was supplied. Advice to those in the Good Diet Group about increasing the consumption of milk, eggs, meat, and cheese resulted in a sub-

Table 3. Percentage of patients in each group on basis of daily consumption of protein, calcium, and vitamin C.

| | Poor Diet | | Supplemented-Good | | Good Diet | |
|---|---|---|---|---|---|---|
| | 1st Record Per Cent | 2nd Record Per Cent | 1st Record Per Cent | 2nd Record Per Cent | 1st Record Per Cent | 2nd Record Per Cent |
| *Protein* | | | | | | |
| Less than 60 gm. | 60 | 38 | 54 | 2 | 23 | 2 |
| 60 to 80 gm. | 33 | 48 | 41 | 20 | 40 | 24 |
| More than 80 gm. | 7 | 14 | 5 | 78 | 37 | 74 |
| *Calcium* | | | | | | |
| Less than 0.8 gm. | 81 | 61 | 86 | 2 | 46 | 2 |
| 0.8 to 1.2 gm. | 16 | 28 | 10 | 10 | 32 | 37 |
| More than 1.2 gm. | 3 | 11 | 4 | 88 | 22 | 61 |
| *Vitamin C* | | | | | | |
| Less than 25 mg. | 82 | 69 | 84 | 2 | 46 | 34 |
| 25 to 50 mg. | 17 | 31 | 15 | 48 | 46 | 56 |
| More than 50 mg. | 1 | 0 | 1 | 50 | 8 | 10 |

stantial increase in the percentage who were taking a reasonable amount of protein. Thirty-six per cent of the Poor Diet Group were getting less than 0.4 gm. of calcium daily. Eighty-six per cent of the patients in the Supplemented Diet Group were getting less than 0.8 gm. of calcium daily, according to our estimated figures in the first record. The addition of milk and cheese to the diet of the Supplemented Group improved the second record greatly. All but 2 per cent were getting more than 0.8 gm. Again the effect of education was noted in the Good Diet Group, in which all but 2 per cent brought the intake of calcium above 0.8 gm. daily. The figures for vitamin C are based only upon the consumption of citrus fruits and tomatoes. They do not include any source of vitamin C in the general diet. It will be noted that the economic level of even the Good Diet Group did not allow the women to purchase more than 50 mg. of vitamin C in citrus fruits or tomatoes.

Table 4 illustrates how the poor diet in the Supplemented Group was improved as far as vitamin $B_1$ was concerned, by giving wheat

Table 4. Vitamin $B_1$ content of low income diets.

| | | Int. Units of Vitamin $B_1$ |
|---|---|---|
| *Original Diet:* | | |
| 8 oz. Potatoes | | 100 |
| 8 oz. Bread—80% White | | 54 |
| 1.5 oz. Cooked Oatmeal (7.5 gm. Dry) | | 13 |
| 10 oz. Milk | | 60 |
| 2.7 oz. Meat (Beef Six Times, Pork Once) | | 67 |
| 4 oz. Vegetable | | 23 |
| 0.5 oz. Egg—¼ Egg | | 7 |
| | | *324* |
| *Supplemented By:* | | |
| 0.5 oz. Wheat Germ | 100 | |
| 30 oz. Milk | 180 | |
| 1 Egg | 30 | |
| 1 Orange | 20 | |
| 4.5 oz. Tomato | 34 | |
| Additions to Meat, Vegetables, and Whole Wheat Bread | *86* | *450* |
| Total | | *774* |

| | Poor Diet | Supplemented-Good Diet | Good Diet |
|---|---|---|---|
| Number of Patients | 120 | 90 | 170 |
| Average Age | 26 | 27 | 25 |
| Average Duration of Prenatal Observation | 4.4 mos. | 4.7 mos. | 4.4 mos. |
| Primipara | 31% | 29% | 46% |
| Percentage of Families on Welfare Relief | 44% | 48% | 3% |
| Average Value of Relief Allowance (Approximate Only) | $7.50 | $8.50 | — |
| Average Weekly Income of Families Not on Relief | $12.02 | $10.94 | $16.94 |
| Average Number of Persons Per Family | 3.0 | 3.7 | 2.8 |
| Average Income Per Person | $3.34 | $2.64 | $6.02 |

Table 5. Patients in prenatal diet study—miscellaneous information.

germ, milk, egg, orange, and tomato, and by changing from white bread to whole wheat bread.

The average duration of observation in the Prenatal Clinic was 4.4 months in the Poor Diet Group, 4.7 months in the Supplemented Group, and 4.4 months in the Good Diet Group (Table 5). The economic status of the patients in the three diet groups is shown in Table 5. Three per cent of the patients in the Good Diet Group were receiving from other sources extra milk, meat, vegetables, and fruits in addition to the relief ration, which allowed them to be in the group improved by education. The past obstetrical records of the multiparous patients showed a much higher incidence of previous major complications in the Poor Diet and Supplemented Groups than in the Good Diet Group (Table 6). Those in the Supplemented Diet Group had experienced more miscarriages, stillbirths, and premature births in previous pregnancies than the Poor Diet Group.

The obstetrician in charge of the patients in the Prenatal Clinic and in the Hospital has given his rating of the condition and progress of the patient in each period of pregnancy. He was unaware of the diet group to which each patient belonged. A "good" or "fair" rating indicated that in his opinion the patient had progressed satisfactorily or with minor complications only. "Poor" or

| | | Poor Diet | Supplemented-Good Diet | Good Diet |
|---|---|---|---|---|
| Past Obstetrical History of Multiparous Patients (Per Cent of Cases): | | 71.4 | 68.7 | 48.9 |
| Abortions | | 13.1 | 4.7 | 9.0 |
| Miscarriages | | 38.1 | 39.0 | 24.4 |
| Prematures | | 10.7 | 20.3 | 13.3 |
| Stillbirths | | 9.5 | 4.7 | 2.2 |
| Obstetrician's Rating During Pregnancy (Per Cent of Cases): | | | | |
| Prenatal Period | Good—Fair | 64 | 91 | 88 |
| | Poor—Bad | 36 | 9 | 12 |
| Labor | Good—Fair | 76 | 97 | 94 |
| | Poor—Bad | 24 | 3 | 6 |
| Convalescence | Good—Fair | 88 | 96 | 91 |
| | Poor—Bad | 12 | 4 | 9 |
| Whole Course of Pregnancy | Good—Fair | 66 | 94 | 85 |
| | Poor—Bad | 34 | 6 | 15 |
| Complications During Pregnancy (Per Cent of Cases): | | | | |
| Anemia | | 28.6 | 16.1 | 21.6 |
| Preeclampsia | | 5.0 | 5.7 | 4.8 |
| Toxemia | | 7.6 | 3.4 | 3.0 |
| Hemorrhage—Prenatal | | 5.9 | 5.7 | 2.4 |
| Threatened Miscarriage | | 8.4 | 1.1 | 2.4 |
| Miscarriage | | 6.0 | 0 | 1.2 |
| Premature Birth | | 8.0 | 2.2 | 3.0 |
| Stillbirth | | 3.4 | 0 | 0.6 |
| Hemorrhage (During Labor) | | 11.2 | 10.3 | 7.7 |
| Endometritis | | 9.0 | 3.4 | 6.1 |
| Mastitis | | 4.5 | 2.3 | 4.8 |
| Breast Abscess | | 3.0 | 1.1 | 2.0 |
| Studies of Blood During Pregnancy (All Values Are Averages): | | | | |
| Hemoglobin at Term | | 11.5 gm. | 12.1 gm. | 11.9 gm. |
| Ascorbic Acid at Term | | 0.47 mg. % | 0.73 mg. % | 0.62 mg. % |
| Ascorbic Acid Cord Blood | | 1.0 mg. % | 1.4 mg. % | 1.3 mg. % |
| Phosphatase at Term | | 16.5 units | 14.5 units | 16.6 units |

Table 6. Observations related to pregnancy.

"bad" meant that many or major complications had arisen. The

rating during the prenatal period, during the actual labor, and during the two weeks of convalescence in the hospital is shown in Table 6. The obstetrician's rating of the whole course of pregnancy from the time that the patient first came under observation in the Prenatal Clinic until she was seen six weeks after the birth of her baby is also presented in Table 6. The mothers in the Supplemented-to-Good Diet Group proved to be better obstetrical risks. The average duration of labor was five hours shorter in this group than in the Poor Diet Group. We noted a marked improvement in the general mental attitude of the patients in the Supplemented Group; many of them lost their minor aches and pains, and no longer had numerous complaints.

During the prenatal period there were more cases of anemia, toxemia, and threatened miscarriage in the Poor Diet Group, while the total number of complications in this group was almost double that in the Supplemented-Good Group (Table 6). The complications which affected the rating during labor in the Poor Diet Group were chiefly 6 per cent of miscarriages, 8 per cent of premature births, and 3.4 per cent of stillbirths, while in the Supplemented-Good Group there were only 2.2 per cent of prematures and no miscarriages or stillbirths (Table 6). After delivery there were fewer cases of uterine or breast infections in the Supplemented-Good Group (Table 6).

The effect of prenatal diet is reflected in the average levels of hemoglobin, vitamin C, and phosphatase in the blood of the mother at the time of delivery (Table 6). The average amount of hemoglobin at the time of delivery was slightly higher in the Supplemented-Good Group. The average level of ascorbic acid in the mother's blood at term and in the cord blood was proportional to the vitamin C obtained by consumption of citrus fruit and tomatoes. Phosphatase is an enzyme which has to do with the laying down of new bone. Phosphatase is increased when there are difficult or abnormal conditions in bone formation. Thus we have found

that the phosphatase of the mother's blood is more than double the average values from the sixth month to term when twins are present (Ebbs and Scott, 1940). The phosphatase in the mother's blood was appreciably lower in the Supplemented Group than in the other two groups. This became apparent from the seventh month onward after the Supplemented Group had been receiving viosterol capsules, while the other two groups had not received a source of vitamin D. This seemed to indicate that expectant mothers receiving vitamin D and an adequate diet were better able to provide for new bone in the developing fetus.

The average birth weight of the babies born of mothers in the Poor Diet Group was 7 pounds 10 ounces; in the Supplemented Group, 7 pounds 7 ounces; and in the Good Diet Group, 7 pounds 6½ ounces. The additional calories do not appear to have influenced the size of the baby.

The relation of prenatal diet to the incidence of breast feeding is shown in Table 7.

Table 7. Observations related to infancy.

| Categories of Interest | | Poor Diet | Supplemented–Good Diet | Good Diet |
|---|---|---|---|---|
| Breast Feeding in Relation to Prenatal Diet (Per Cent of Cases): | | | | |
| In Hospital | Breast Feeding | 81 | 95 | 88 |
| | Artificial Feeding | 19 | 5 | 12 |
| Six Weeks After Birth | Breast Feeding | 59 | 86 | 71 |
| | Artificial Feeding | 41 | 14 | 29 |
| Principal Illnesses in Babies During First Six Months (Per Cent of Cases): | | | | |
| Frequent Colds | | 21.0 | 4.7 | 4.7 |
| Bronchitis | | 4.2 | 1.5 | 5.7 |
| Pneumonia | | 5.5 | 1.5 | 0.9 |
| Rickets | | 5.5 | 0 | 0.9 |
| Tetany | | 4.2 | 0 | 0 |
| Dystrophy | | 7.0 | 1.5 | 0 |
| Anemia | | 25.0 | 9.4 | 17.1 |
| Deaths | | 3 | 0 | 0 |

An attempt is being made to follow the progress of the babies born of the mothers in this study to determine the influence, if any, of prenatal diet upon the future condition of the baby. These observations are not completed, but a brief summary can be given of the first 250 babies followed to the age of six months (Table 7). The increased incidence of minor and major diseases in the babies born of mothers in the Poor Diet Group is quite striking. The general condition of the babies in the Supplemented and Good Diet Groups was on the whole much better. In a large proportion one could tell the diet group of the mother by looking at her baby. Two of the three infant deaths in the Poor Diet Group resulted from pneumonia, and the other from prematurity.

## Summary

The prenatal diets of 400 women with low incomes were studied. One group found to be on a poor diet was left as a control, a second group on a poor diet was improved by supplying food during the last three or four months of pregnancy, and a third group, found to have moderately good prenatal diets was improved by education alone.

During the whole course of pregnancy the mothers on a good or supplemented diet enjoyed better health, had fewer complications, and proved to be better obstetrical risks than those left on poor prenatal diets.

The incidence of miscarriages, stillbirths, and premature births in the women on poor diets was much increased.

The incidence of illness in the babies up to the age of six months and the number of deaths resulting from these illnesses were many times greater in the Poor Diet Group.

## Conclusion

While it is recognized that there are other important factors in the successful outcome of pregnancy, this study suggests that the

nutrition of the mother during the prenatal period influences to a considerable degree the whole course of pregnancy, and in addition directly affects the health of the child during the first six months of life.

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