Nutritional Status and the Outcome of Pregnancy

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Abstract

Evidence is presented that nutrition intervention during pregnancy can have a significant influence on the outcome of pregnancy. The Montreal Diet Dispensary gave nutrition counselling and necessary food supplements to 1,736 maternity clinic patients of the Royal Victoria Hospital between 1963 and 1972. The counselling method used was a procedure for an assessment of nutritional status, including the addition of corrective allowances to caloric and protein requirements equal to assessed deficiency, to provide for maternal nutritional rehabilitation during pregnancy and permit optimal growth and development of the foetus.

During the service the average intake was increased by 529 calories and 33 grams of protein, but there were great differences between the intakes of mothers with good or poor nutritional status. Birth weights were significantly higher at the .01 level for siblings in the study than for siblings when the mother did not receive our counselling. Birth weights were significantly higher for the higher pregravid weights, larger maternal weight gain, for longer periods of Diet Dispensary service, and for degree of compliance with the method. Mothers who smoked had smaller infants, but consumed more energy and protein. There was a significant negative correlation between hemoglobin level at 36 weeks' or more gestation and birth weight. The perinatal mortality (14.3/M), prematurity (6.8%), and birth weight (3,274) in the study group were similar to those of private patients and significantly lower than for the other public clinic patients.

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Introduction

There is a genetic design for growth and development during the fetal period which cannot be fulfilled without adequate nutrition. Any nutritional deficiency during pregnancy which results in the failure of normal development of the fetus represents a large social and financial loss to the nation. A 1970 estimate by Ronald W. Conley indicates that society would gain $900,000 for each case of severe mental retardation which could be prevented. He also reports that the incidence of mental retardation is 13 times greater for the children of the poor than the children of the middle and upper classes.[1]

The incidence of disability in any nation is a matter of great concern. The measurement depends upon arbitrary choices of degrees of disability so that different surveys are difficult to compare. In Quebec the provincial government estimates that approximately 15% of all children under age 18 in the province suffer from some form of mental or physical disability.[2] This figure is similar to

that (16%) found in a study of all the children from nine to 12 years of age on the Isle of Wight. This 16% is made up of 5.5% who suffer from some form of physical handicap, and 10.6% who suffer from some form of mental handicap.[3]

An analysis of individuals in the United States in whom long-term disabilities originated prior to age 18 revealed that in 75% of the cases the defect had its origin before birth, and in 94% the disability was neurological.[4] These findings are responsible for the statement given in press releases, "at birth you are programmed for life".

The increasing interest of government in preventive programs is a result of a greater understanding of the origin, extent, and cost of disability. The President's Committee on Mental Retardation established by the late President Kennedy in the United States reported in 1972 that the incidence of mental retardation can be reduced by 50% with improved programming in maternal and infant care.[5] The origin of much mental and physical subnormality occurs during the perinatal period between the 28th week of gestation and the first week after birth. A study by the French government concludes that more than half of all mental subnormality and more than 90% of cerebral palsy and spasticity are perinatal in origin and could be prevented with improved services.[6]

Numerous studies indicate that birth weight is of major significance in both infant mortality and morbidity. Butler and Alberman found that the perinatal mortality rate was 227 per thousand in low birth weight babies weighing less than 2501 grams, falling to 28.2 at 2501 to 3000 grams, and decreasing further to 12.4 at 3001 to 4000 grams.[7] In Canada 25% of all birth weights are below 3001 g. Singer *et al* found low birth weight is related to increased incidence of stillbirth, neonatal death, poor infant development, cerebral palsy, mental retardation and lowered intelligence.[8] There is a direct relationship between the incidence of perinatal mortality and the incidence of disability in the survivors. The French estimates show two surviving severely handicapped children for every perinatal death.[6] Perinatal mortality rate can be compared to the tip of the iceberg relating to the size of the submerged portion of survivors with disability, thus, when the perinatal mortality decreases in any population, disability also is decreased.[9]

Dobbing demonstrated that the period of maximum brain growth in humans occurs late in pregnancy.[10] Winick found in 16 infants who had died of kwashiorkor and marasmus that those of normal birth weight showed a five to 20% reduction in the number of brain cells, whereas those of low birth weight showed a 60% reduction.[11] Roeder and Chow found that rats fed an inadequate diet during pregnancy produced offspring with reduced birth weight and survival, permanently stunted growth, defective metabolism, and abnormal behavioral problems.[12]

The relationship between maternal factors and infant mortality and morbidity have received extensive study. Bergner and Susser,[13] Naeye,[14] Shah and Abbey,[15] have studied the effects of age, race, and socio-economics on infant mortality in New York and Baltimore. In general they found that infants born in poverty have higher mortality rates because of the lower birth weight, and that age, race, and socio-economics, were important only insofar as they were related to birth weight. In a study of the comparison of birth weight of infants from private and public patients at the Royal Victoria Hospital in 1961 and 1962, it was found that there was a 120 gram difference in favor of the private over public

patients.[16] This small statistical difference in birth weight had a great biological effect, accounting for a 50% increase in perinatal mortality and a 60% increase in low birth weight among the infants of the public patients. Rush found the same 120 gram difference between the average birth weight of the newborn of white and black mothers in Rochester, New York, in favor of the whites, which accounted for twice the infant mortality among the black infants.[17]

Differences in birth weight among infants of different income groups are due to differences in growth in the last trimester.[18] Tompkins and Wiehl were the first to demonstrate the underweight patient as an obstetrical risk.[19] A high positive relationship between birth weight and maternal pregravid weight and weight gain during pregnancy has been reported in numerous studies. Singer et al, in the Collaborative Study, found a significant reduction in morbidity and an improvement in growth and development in infants from mothers with above average weight gain during pregnancy.[8]

Both pregravid weight and weight gain during pregnancy are influenced by nutrition. Several authors, including the Committee on Maternal Nutrition of the National Academy of Sciences, concluded that the restriction of weight gain during pregnancy through low calorie regimes was undesirable and partly responsible for the high prevalence of low birth weight in the United States.[20] Pitkin and his colleagues, members of the Committee on Nutrition of the American College of Obstetricians and Gynecologists, concluded that low salt intake or the use of diuretics in pregnancy are undesirable.[21]

Recent research on nitrogen balances in pregnant women illustrates the importance of the balance and quality of diet in pregnancy. The Harvard studies showed many years ago that there was an association between protein content of the maternal diet and birth length, birth weight, and pediatric rating of the newborn.[22] Early nitrogen balances reported by Oldham and Sheft showed that low nitrogen retention and low efficiency of dietary protein utilization resulted from low caloric intake.[23] King, Calloway and Margen at the Department of Nutritional Sciences, Berkeley, California, showed more recently in their nitrogen balance studies that a 30 g protein allowance in pregnancy is desirable to achieve an adequate nitrogen balance.[24] The National Academy of Sciences have subsequently increased the recommended dietary protein allowance for pregnancy from 10 g to 30 g.[25]

Less well-known in North America are some European results of nitrogen balance studies by Gontzea, which were drawn to my attention by Arthur Wynn from a 350-page German textbook on maternal nutrition as shown in the following table.[26] This table covers nitrogen balances measured at a number of different centres covering 1360 days mainly during the last trimester of pregnancy. The author concluded from these and other data that a 90 g daily intake of protein was the minimum dietary allowance that could be recommended for pregnancy, accepting that a positive balance of at least +2.0 g was desired. Earlier estimates by the World Health Organization were too low both because they underestimated maternal nitrogen storage in a healthy pregnancy and overestimated the efficiency with which protein is used.

Other maternal factors relating to birth weight in addition to prepregnancy weight and weight gain during pregnancy, are smoking, and the previous obstetrical birth weight record. The association to birth weight of other maternal factors as age, parity, marital status, income, height, are negligible when con-

Nitrogen Balance and Different Protein Intakes During Pregnancy

Protein intake per day g	Number of days	Average nitrogen balance in g	Number negative	Percentage negative
Under 56	54	−0.42	28	52
56- 70	146	+0.52	31	21
70- 85	419	+1.21	42	10
85-100	252	+2.10	5	2
100-115	203	+2.39	4	2
115-130	201	+4.24	4	2
Over 130	85	+6.40	1	1

trolled for mother's size, gain, smoking, etc. These findings have been interpreted as supportive of the hypothesis that nutrition during pregnancy is a determinant of birth weight. Smoking habits of the mother have a detrimental effect on birth weight through interference with metabolic processes.

A scientific assessment by Birch and Gussow[22] of the detrimental effect of poverty on health, nutritional status, physical and mental development and the intellectual potential of children, shows that poverty begets poverty. From this cycle of defeat it is obvious that disadvantaged mothers give birth to disadvantaged children of low birth weight who, in turn, give birth to disadvantaged children and thus the cycle is perpetuated.

How much of the disadvantage of the poor may be attributed to the 'seed' or genetic factors, or how much to the 'soil', which includes nutritional or environmental factors, is not known. The question arises, can the poverty cycle be broken by improving the nutritional status of disadvantaged mothers during pregnancy through scientific counselling and food supplementation to produce infants of the same size and quality as those of the advantaged mothers? Or stating the matter in another way, can the nutritional status of an undernourished underweight mother be sufficiently improved in the short time available during pregnancy to ensure the production of an infant with normal birth weight?

Studies have demonstrated that women enter pregnancy in varying degrees of nutritional status. There is a great need for an intervention method of nutritional counselling which includes nutritional assessment and therapeutic procedures for the rehabilitation during pregnancy of underweight and undernourished mothers to ensure normal growth and development of the fetus.

From our experience at the Montreal Diet Dispensary starting in 1948, working closely with hundreds of malnourished pregnant women whose family incomes were below the poverty level, we became aware of the very poor obstetrical history of these women, as well as their poor nutritional status and of the need for such a nutritional rehabilitation method, and over a period of 15 years gradually developed one.

In 1963 the Dispensary began a study with the collaboration of the Royal Victoria Hospital to test and improve this method with the mothers attending their public maternity clinics which is still continuing. In the first year of the study all the mothers registering at the Friday afternoon clinic were included, and in the second year we extended the study to those attending the Chandler Thursday afternoon clinic. Since 1971 we have included every other mother

registering at all the public clinics except those at the Tuesday afternoon for Greek speaking patients. Following is a description of the methods.

METHODS

I Procedure for estimation of caloric and protein requirements

Normal requirements

The normal caloric and protein requirements for mothers 20 years of age or more are determined on the basis of ideal body weight, physical activity, and week of gestation, according to the recommendations in the Dietary Standard for Canada (1948) prepared by the Canadian Council on Nutrition.[28] For mothers 19 years of age or less we use Recommended Dietary Allowances (1958) prepared by the Food and Nutrition Board, National Research Council, United States.[29] For all mothers we add 500 calories and 25 g of protein after 20 weeks of gestation as recommended in the Canadian standard.

Additional corrective allowances

Corrective caloric and protein allowances are given in addition to the normal requirements according to the degree of undernutrition, underweight, or for special high risk conditions which may be indicative of nutritional stress. A mother may have none or one or more of these conditions.

II Procedure for estimation of corrective allowances

Undernutrition assessment and rehabilitation

Undernutrition is determined if a protein deficit is found between actual dietary intake and requirement. The method used is a 24-hour recall diet history, cross-checked with a food list and family market order compared with the appropriate standard.

Undernutrition correction is equal to the amount of protein deficit allowing 10 calories for each gram of protein added to normal pregnancy requirements.

Underweight assessment and rehabilitation

Underweight status is determined if the mother's pregravid weight is 5% or more under the weight recommended in the Table of Desirable Weights, prepared by the Metropolitan Life Insurance Company.

Underweight correction should provide sufficient additional calories and protein to ensure that the mother gains during pregnancy the number of pounds she was underweight prior to conception. We allow 20 g of protein and 200 calories a day added to normal pregnancy requirements to permit a gain of one pound per week. Since 1971 the calorie correction has been changed from 200 to 500 calories.

Nutritional stress assessment and rehabilitation

Nutritional stress is determined if any one of the following maternal conditions is present: pernicious vomiting, pregnancies spaced less than one year apart, previous poor obstetrical history, failure to gain 10 pounds by 20th week, serious emotional problems.

Nutritional stress correction provides for the addition of 20 g of protein and 200 calories for each stress condition added to normal pregnancy requirements.

III Nutrition counselling

When the mother's caloric and protein requirements have been determined, nutrition counselling begins. The recommendations as to the kinds and amounts of food the mother should eat in order to meet her individual requirements for calories and protein are based on the mother's own dietary pattern and Canada's Food Guide. Changing eating patterns can be traumatic so only necessary minimum changes are made.

Since we use milk principally to make up the deficiency in calories and protein between the mother's actual intake and her requirements, the major change our mothers have to make is to increase their milk consumption. Because our mothers are not accustomed to drinking milk, they find it easier to do when told that they are drinking the milk not for themselves but for the baby.

It is very important that the nutritionist establish a good personal relationship with the mother. Mothers whose incomes are below the poverty level and therefore could not afford to buy the necessary food receive a food supplement of milk, eggs, and oranges, to make up the nutritional deficit. All mothers receive a vitamin and mineral supplement. We do not restrict salt or use diuretics.

After the first interview, the mother is seen regularly and at each appointment a diet history is taken to determine if instructions are being followed. Constant encouragement and support are given by the nutritionist. At these interviews the weight of the mother is recorded and, if necessary, the food supplement is given. The supervision is continued until the baby is born. After the birth, a detailed report of the case is recorded on a summary sheet for subsequent analysis. Before the initial interview concerning assessment and counselling, a home visit is made to establish a friendly contact and to make arrangements for the first appointment.

In our procedure it is necessary for the dietitian to practice both the science and the art of her profession. Scientific knowledge is needed so that the nutrient value of the kinds and amounts of foods recommended to each mother meet her nutrient requirements. However, the success of the counselling is determined by the dietitian's additional ability to influence the mother to follow the directions. The mother's compliance is dependent on the art of the dietitian to understand and motivate her patient. Understanding begins during the home visit and grows during the initial interview while gathering the information. From the process the dietitian becomes interested in the mother and develops a desire to help her. The mother responds to this concern and listens to the teaching and has faith in her dietitian's directions.

Results

Table 1: Study Group 1963-1972

	Number	Percentage
Cases started	1833	100
Cases completed	1736	95
Food supplement provided	1246	72
Illegitimate pregnancies	547	32

The dropout rate in the study was 5%. The high percentage of mothers with income below the poverty level who required food supplement, and the frequency of illegitimate pregnancies, indicate that the group under study included an abnormally high proportion of 'disadvantaged mothers'.

Table 2: Dietary record 1963-1972

	Caloric intake (cal.)	Protein intake (g)
Initial prior to Diet Dispensary service	2249	68
During Diet Dispensary service	2778	101

During our service, the mean daily intake for all cases was increased by 529 calories and 33 g protein but varied greatly according to nutritional status. For example, the average increase in intake in the undernourished group was 784 calories and 43 g of protein as compared with 210 calories and 16 g of protein for the good nutritional status group of mothers.

Table 3: Maternal Nutritional status vs. birth weight 1963-1972

Maternal nutritional status	Number	Birth weight (g) not adjusted	Birth Weight 2501 g or less % of total
Good	217	3428	5.07
Undernourished	302	3418	3.31
Nutritional stress	134	3360	4.48
Underweight	75	3297	2.67
More than one condition above	347	3220	6.60

The mean birth weight of the infants of the mothers who were undernourished at the beginning of pregnancy was 3418 grams, only 10 grams less than for the infants of mothers who entered their pregnancy with good nutritional status. These results demonstrate the effectiveness of the therapeutic procedures of our method for improving maternal nutritional status and you will note that the average increase in birth weight was over 120 g and thus we have broken the poverty cycle—taking away the effect of "previous obstetrical record".

Table 4: Siblings with or without Diet Dispensary treatment vs. birth weight 1963-1972

		Birth weight g not adjusted		
Maternal nutritional status	Number	Previous sibling without DD service	Sibling with DD service	Difference with DD service
Good	103	3469	3488	19
Undernourished	142	3317	3476	159
Nutritional stress	68	3207	3385	178
Underweight	36	3043	3232	189
More than one condition above	148	3102	3251	150

There was only a 19 g difference in birth weight for the siblings of mothers who entered pregnancy in good nutritional status as compared with a 150 g or more difference for the siblings of those mothers who entered our service under-

weight, undernourished, or under stress. These results demonstrate the reliability of the method of nutritional status assessment as well as the effectiveness of the therapeutic treatment for nutritional deficits.

Table 5: Sibling Study

Effect of Diet Dispensary treatment or lack of it on birth weight and duration of pregnancy 1963-1972

Sibling groups	Number	Birth weight g	Duration of pregnancy weeks
		LSE[a]	LSE[a]
Pre DD	828	3224	39.21
DD	1007	3311	39.57
Post DD	298	3188	38.88

[a]LSE expressed as the mean plus the least squares estimate of the deviation from the mean.

There were 1007 mothers in the study who had other siblings born at the Royal Victoria Hospital without DD treatment. A total of 828 siblings were born before the mother received DD service, and 298 siblings were born after the mother had received DD service. A least squares analysis adjusting for the effects of mother, age of mother, parity, and sex of offspring, found significant ($p. < .01$) differences in birth weight and duration of pregnancy between treated and non-treated siblings whether born prior to or after the pregnancy with DD service.

Table 6: Length of Diet Dispensary treatment vs. birth weight and maternal weight 1963-1972

Treatment started trimester	Number	Birth weight g adjusted	Maternal weight kg		
			Pregravid weight	Weight gain	Post partum weight gain
First	218	3403	57.3	12.1	3.5
Second	610	3353	56.9	11.3	2.5
Third	247	3266	57.7	10.3	1.7

The birth weight was increased with the length of treatment, as was the maternal weight gain during pregnancy and post partum. The overall increase in the caloric and protein intake was roughly three times greater for the mothers who registered in the first trimester, and twice as great for the mothers who registered in the second trimester, as for those who came to the clinic in the third trimester. It is evident that the earlier our counselling was started the better was the effect on the birth weight.

Table 7: Influence of Duration of Nutrition Counselling on Birth Weight and Perinatal Mortality 1963-1972

Duration of Counselling	Total live births	Birth weight g	Under 2501 g		Total live births	Perinatal Mortality	
			No.	%		No.	Rate/M
1-12 weeks	519	3177	51	9.83	527	14	26.6
13-20 weeks	499	3244	39	7.82	501	5	9.9
21 or more weeks	713	3365	29	4.07	718	6	8.3
Total	1731	3274	119	6.87	1746	25	14.3

The percentage of low birth weight babies fell with the length of our service from 9.8 for infants of mothers with 1 to 12 weeks' service to 4.07 for those who received over 20 weeks' service. Perinatal mortality also fell from 26.6 to 8.3 rate per thousand with length of service.

Table 8: Per cent of protein consumption vs. birth weight 1963-1972

Per cent of required protein consumed	Number	Birth weight g not adjusted	Protein g
Less than 85%	314	3234	88
85% to 114%	513	3327	103
115% or more	339	3446	114

There is a direct relationship between birth weight and the percentage of protein requirement consumed by the mother. The degree of compliance of the mother in following the nutritionist's counselling varied. The highest birth weights were found in the groups of infants whose mothers took 115% or more of their protein requirement. This may indicate that the protein requirement recommended in the Dietary Standards for Canada, 1948, which we are currently using, does not promote optimal growth and development.

Table 9: Maternal smoking habits vs. birth weight 1968-1972

Maternal smoking habits	Number	Birth weight adjusted mean (g)	Maternal weight gain (lbs)	Maternal Calorie intake	Maternal Protein intake (g)
Non-smokers	374	3295	26	2598	94
Smokers					
Quit smoking during DD service	18	3266	30	2837	103
Smoked 20 or less cigarettes daily	132	3226	26	2871	103
Decreased from smoking 20 or more to less than 20 daily	33	3210	22	2824	104
Smoked 20 or more cigarettes daily	75	3118	23	2803	103

In 1968 we included in the study for the first time information concerning the smoking habits of the mothers. The birth weight of the infants of mothers who smoked was less despite the greater calorie and protein intake. As the level of smoking increased, the birth weight was reduced. Our nutritionists now inform the mothers of the detrimental effects of smoking on birth weight and urge them to eliminate or curtail the habit.

Table 10: Pregravid weight of mother vs. birth weight 1963-1971

Pregravid weight Range (kg)	Mean (kg)	Number	Birth weight adjusted mean (g)
<48	43.7	249	2967
48-53	50.3	402	3107
54-59	56.5	395	3251
60-65	62.4	241	3305
66-71	67.8	145	3373
>71	82.0	153	3455

There was a significant relationship between the increase in the birth weight and the increase in the maternal pregravid weight. The average increase in birth weight was 15 g per kg of the maternal pregravid weight. The relationship tends to be curvilinear with a greater increase in birth weight at the lower than at the higher maternal weight. This relationship is attributable to the higher proportion of underweight mothers in the lower weight group and of overweight mothers in the higher weight group.

Table 11: Weight gain of mother during pregnancy vs. birth weight 1963-1971

Weight gain Range (kg)	Mean (kg)	Number	Birth weight adjusted mean (g)
<8	4.6	350	2998
8- 9	8.5	222	3237
10-11	10.4	328	3208
12-13	12.5	238	3345
14-15	14.6	199	3356
>15	18.6	248	3392

The birth weight increases with the weight gain of the mother. The relationship tends to be curvilinear with greater increase in birth weight at the lower maternal weight gain than at the higher level.

There are advantages in increased birth weight when the maternal weight gain is greater than the traditionally accepted optimal gain of 10-11 kg. There was no evidence that high maternal weight gain or large birth weight presented obstetrical problems.

Table 12: Hemoglobin level at 36 weeks' pregnancy vs. birth weight 1963-1972

Hemoglobin level g/100 ml	Number	Birth weight g not adjusted
9.7 or less	21	3513
9.8 to 10.7	95	3436
10.8 to 11.7	284	3396
11.8 to 12.7	303	3362
12.8 to 13.7	130	3304
over 13.7	27	3138

There is a highly significant negative relationship between the maternal hemoglobin level at the 36th week of gestation and birth weight. The inverse relationship is suggestive of hypervolemia in patients with low hemoglobin levels and hypovolemia in those with high levels.

Table 13: Incidence of perinatal mortality 1963-1972

Populations	Live births and Stillbirths	Perinatal deaths	Perinatal death rate per thousand
Diet Dispensary Study	1,746	25	14.32
Canada	3,813,217	95,275	24.99
Quebec	1,064,986	27,702	26.01
R.V.H. public*	8,445	162	19.18
R.V.H. private*	17,644	233	13.21

*Royal Victoria Hospital public or private patients without DD service.

Table 14: Incidence of low birth weight 1963-1972

Populations	Live births	Infants of low birth weight**	Low birth weight %
Diet Dispensary Study	1,731	119	6.87
Canada	3,770,692	288,346	7.65
Quebec	1,053,243	95,009	9.02
R.V.H. public*	8,344	754	9.04
R.V.H. private*	17,524	1,084	6.19

*Royal Victoria Hospital public or private patients without DD service.
**Weight under 2501 g.

The incidence of perinatal mortality and low birth weight among the Diet Dispensary cases was comparable to those among the private patients and significantly lower than for those of the other public clinics without the service. The Diet Dispensary's rate was also lower than the average for Canada and Quebec. The incidence of low birth weight was four percent in this study for the infants of the 75 school-aged mothers of 17 years or less and for the infants of the mothers who had 21 or more weeks of service.

Birth weight relationships

The birth weight of the infant varied with the length of gestation and sex of the infant. With each additional week of gestation the birth weight was increased by 115 g. Males were 144 g heavier than females and *prima para* babies were 65 g lighter than *multi para* babies. Apart from these factors, the birth weight was influenced by three variables; the size of the mother, maternal weight gain during pregnancy, and smoking habits. Other influences such as maternal age, height, parity, and economic and social factors have an effect only insofar as they influence the size or weight gain of the mother.

The average birth weight among the single live births in the study was 3274 g which was approximately the same as that of the infants of the private patients in the same hospital. It has been stated in the preceding tables whether or not birth weight has been adjusted for the effect of the other variables not being studied.

Discussion

The evidence in this study indicates that birth weight and survival are improved with the provision of nutrition counselling and food supplementation when necessary during pregnancy. Of still greater importance is the effect of the service on the growth and development of the child.

Figure 1 indicates the birth weight record of 11 children of a 29-year-old mother who delivered her children at the Royal Victoria Hospital. The third child died at the age of one month. The mother received nutrition service from the Diet Dispensary only during the last three pregnancies. The birth weight of these children was greater than that of the others. A physical and mental assessment of all the children was done at the Montreal Children's Hospital and indicated that the last three children are normal, whereas the others were found to be disadvantaged and there was considerable doubt as to their ability to succeed.

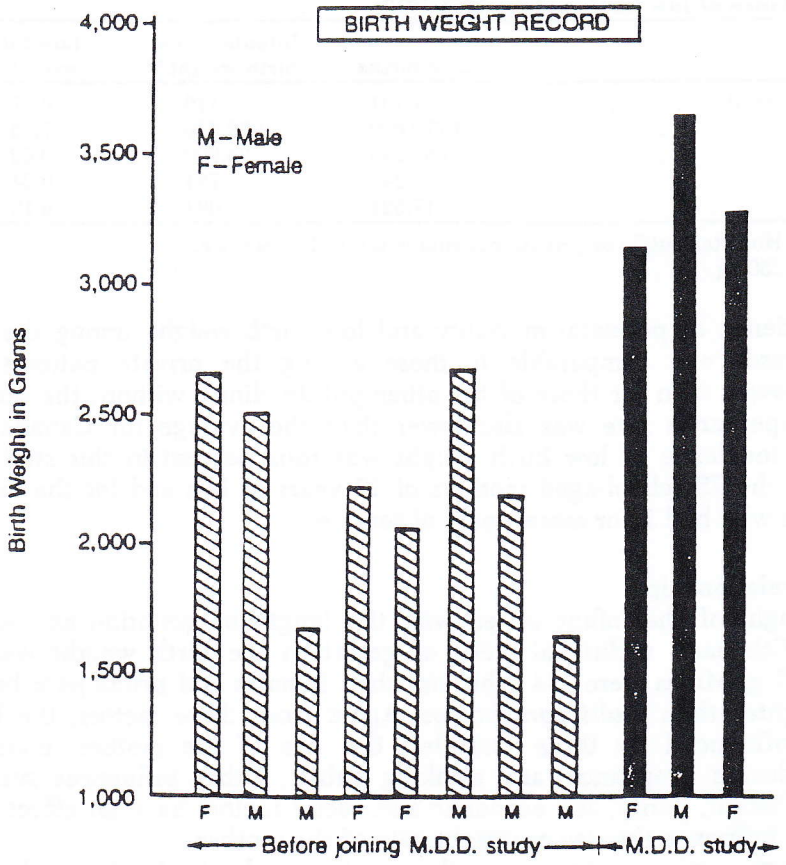

Figure 1

Her first child, an unmarried daughter at home, had her first illegitimate baby last year, thus perpetuating the poverty cycle. Her second child, a son, is in and out of difficulties. The cost of the Diet Dispensary's service for each case—including the food supplementation—was $125.00 whereas the estimated cost to the state of maintaining a deficient child for a life-time is more than a thousand times as great.[30] Such is the cost-benefit analysis of this case.

This is an interim report of the study as the work is still progressing and what remains to be done is to determine the relationship between nutritional status and obstetrical and pediatric data which is now being analyzed by Columbia University's Department of Epidemiology, and to conduct a sibling study to determine if treated siblings have had better growth and development and improved educational records than the untreated siblings.

The reproductive performance of a large fraction of the 1,736 pregnant women treated by the Montreal Diet Dispensary was improved by nutrition counselling and supplementation. Both the cost and the highly trained nutritionists needed make it impossible to extend such intensive methods to all pregnant

women. It follows that screening procedures are essential to decide which women should be the subject of such intensive methods. Much further work is needed to develop, test and validate simple procedures that can form a part of routine prenatal care and would select the minority of women who would profit most from intensive nutrition counselling or supplementation. This is one major task for the future.

Nutritional habits are very diverse. The task of modifying habits to improve the outcome of pregnancy will challenge the ingenuity and skill of many future investigators. While the intensive nutrition counselling methods developed by the Montreal Diet Dispensary are effective, they are certainly capable of further improvement. There is also much still that we do not know about the optimum diet of pregnant women.

There is also a wider subject meriting much further study, namely, the comparative merit of different systems for delivering prenatal care and better nutrition as part of prenatal care. France has substantial prenatal money allowances which ensure that a high percentage of all pregnant women report for prenatal care early in pregnancy.[31] The USA has the WIC Program for some low-income mothers registering for prenatal care.[32]

The Scandinavians, who achieve the best results, place great emphasis on the community nurse and on home visiting to promote a high coverage of pregnant women by the prenatal services. Finland has, for example, both a strong prenatal community nursing service and pays a bonus for early attendance at prenatal clinic.[33]

There is much in these different systems for delivering prenatal care and prenatal nutrition that is outside the experience of the Montreal Diet Dispensary. However, medical knowledge and nutrition services do not benefit people they do not reach, and the greater the efficacy of our techniques the more urgent it becomes to devise systems for reaching all pregnant women who need it.

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