THE ROLE OF NUTRITION IN PREVENTIVE MEDICINE

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FROM the public health standpoint we are not concerned with the so-called nutritional deficiency diseases. They do not constitute a public health problem. For instance, at the Hospital for Sick Children in Toronto, in 1925 we had 154 cases of rickets. Ten years later, in 1935, in place of 154 cases, we had four. The medical student today goes through the University of Toronto without ever seeing a case of rickets.

We average seven cases of scurvy a year, and the attendances at the hospital approximate 100,000 per year. In the last one and one-half million attendances at the hospital, we have had one case of xerophthalmia, and beriberi and pellagra are unknown. These nutritional deficiency diseases do not constitute a public health problem for us.

Where does nutrition enter into public health? From dietary surveys made in the United States and Canada, it would appear that as many as one-third of the populations of both countries are receiving diets which are not in line with optimum health. The dietary deficiencies can be regarded as of moderate degree rather than severe. The deficient intake, however, tends to be of long duration. Dr. Kruse (1) some two years ago pointed out that the abnormal conditions which develop as the result of a chronic moderate lack of various nutrients not only develop slowly but also respond slowly when the deficiency is corrected.

In addition to the question of chronicity, one must keep in mind that the signs of ill health and impairment of efficiency appear under periods of stress and strain. A diet that may be markedly defective does not interfere with the efficiency of the individual if he is spending his time in bed. He can still be a very efficient bedridden individual; but if he is active, carrying on in this busy life,

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the diet may not be sufficient to give him optimal health. This is the second point to emphasize, namely, the effect of stress and strain on nutritional requirements.

Do not forget that all the nutritional work on animals has been done, or most of it has been done during the period of growth, under the stress and strain of growth. There is the strain of pregnancy, the strain of severe exertion, both mental and physical. There is the strain of exposure to unfavorable surroundings, such as toxic materials. There is the strain of extremes of climate, hot and cold, and wind and glare, and there is the strain of infection.

When one examines the evidence showing the effect of diets that are not perfect, but still good enough to prevent any deficiency disease, one is led to the conclusion that there is no one single factor today which so affects the health of the individual as the food he eats. Now, what evidence do we have to support this rather sweeping statement?

Table 1. Weekly amounts of food supplied.[1]

Type of Food	Weekly Amount
Milk	10 Pints (Imp.)
Tomatoes	32 Ounces
Wheat Germ	14 Tbsps.
Viosterol	2,000 I.U. Daily
Eggs	7
Oranges	7
Cheese	½ Pound

Analysis of Daily Food Supplied

Protein (gms.)	Fat (gms.)	Carbohydrate (gms.)	Calories	Calcium (gms.)	Iron (gms.)
45	46	60	840	1.45	.015

[1] Ebbs, J. H.; Tisdall, F. F.; and Scott, W. A.: The Influence of Prenatal Diet on the Mother and Child. The Milbank Memorial Fund *Quarterly*, January, 1942, xx, No. 1, pp. 35-46.

The first study shows the effect of food on the child, the unborn child. While we are speaking of the unborn child, we will also consider the effect of food on the pregnant woman. In Toronto Dr. Ebbs (2) (3) and those associated with him studied three groups of women coming into the prenatal clinic. Today we will consider only two groups—mothers that were on a poor diet and mothers on the poor diet but given additional foods through the generosity of a Toronto business man. The extra food supply, shown in Table 1, included an egg a day, thirty ounces of milk, an ounce of cheese, about four and one-half ounces of tomatoes, an orange a day, one-half to one ounce of wheat germ, plus some vitamin D.

The women in the poor-diet group were originally getting 55 grams of protein a day, although they should have been getting 85 to 100. They were taking only 1,600 to 1,700 calories, yet they could easily have eaten more bread, more food which they had in the house. They should have been taking 2,500 calories. Their calcium was half a gram instead of 1.5 grams and their iron was 10 instead of 15 mgs.

Before the women in the other group were given the additional food, their diets were similar to those in the poor-diet group. In place of 55 grams of protein, they were getting 57; they were receiving 1,660 calories. The calcium intake was .5 grams, the iron intake was 10 mgs. The two groups of women were identical in so far as we could determine from the standpoint of their nutritional intake.

The women in both groups were observed throughout pregnancy. The obstetrician had no idea in which group they belonged.

Later on, when subsequent surveys were made, it was found that the diets of the poor group had improved very little; 55 to 64 grams of protein per day, the intake from calories was from 1,600 to 1,900, from .5 to .7 grams of calcium, and from 10 to 11 mgs. of iron. Those who were given the extra food had reached an approved level; the increases were from 57 to 97 grams of protein, from 1,600 to 2,500 calories, from .5 to 1.6 grams of calcium, and from 10 to 24 mgs. of iron. None of the women in the poor diet group had any signs of any deficiency diseases, yet they were not efficient as pregnant women bearing healthy, normal children.

The prenatal ratings by the obstetrician, which appear in Table 2, show that 36 per cent of those in the poor-diet group had a poor or bad record as compared to only 9 per cent when the diet was made good.

Table 2. Prenatal rating by obstetricians.[1]

Quality of Diet	Rating	
	Good—Fair	Poor—Bad
	Per Cent	
Poor Diet	64	36
Supplemented—Good	91	9
Good Diet	87	13

[1] Ebbs, J. H.; Tisdall, F. F.; and Scott, W. A.: The Influence of Prenatal Diet on the Mother and Child. The Milbank Memorial Fund *Quarterly*, January, 1942, xx, No. 1, pp. 35-46.

The ratings by the obstetricians of the conditions during labor are shown in Table 3. Twenty-four per cent of the mothers in the poor-diet group had a poor or bad record as compared to only 3 per cent when the diet was made good. There were, roughly, one hundred women in each group.

The average duration of the first stage of labor is presented in Table 4. The women (primipara) in the poor-diet group took 20 hours as compared to 15 hours when the diet was good. The multipara on the poor diet took 11 hours against 9.5 hours for those on the good diet. The latter were more efficient women.

Table 3. Rating by obstetrician of condition during labor.[1]

Quality of Diet	Rating	
	Good—Fair	Poor—Bad
	Per Cent	
Poor Diet	76	24
Supplemented—Good	97	3
Good Diet	94	6

[1] Ebbs, J. H.; Tisdall, F. F.; and Scott, W. A.: The Influence of Prenatal Diet on the Mother and Child. The Milbank Memorial Fund *Quarterly*, January, 1942, xx, No. 1, pp. 35-46.

During convalescence the record is similar to that during labor; 11.5 per cent gave a poor or bad record when they were on the poor diet as compared to 3.5 per cent when the diet was made good.

In regard to the effect on the child, the condition and progress of the baby during the first two weeks, 14 per cent of the babies from the mothers who were poorly nourished gave a poor or bad record as compared to none who came from the mothers who were well nourished.

Table 4. Average duration of first stage of labor.[1]

Quality of Diet	Hours	
	Primipara	Multipara
Poor Diet	20.3	11.1
Supplemented—Good	15.2	9.5
Good Diet	18.3	9.9

[1] Ebbs, J. H.; Tisdall, F. F.; and Scott, W. A.: The Influence of Prenatal Diet on the Mother and Child. The Milbank Memorial Fund *Quarterly*, January, 1942, xx, No. 1, pp. 35-46.

It was recognized that data of illnesses during the first six months of life perhaps will not bear the scrutiny of most careful study because they are defective to a degree since they are dependent on the statements of the mothers themselves. As far as could be determined, the babies in the two

Table 5. Principal illnesses in babies during first six months.[1]

Cause of Illness	Quality of Diet		
	Poor	Supplemented—Good	Good
	per cent		
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

[1] Ebbs, J. H.; Brown, A.; Tisdall, F. F.; Moyle, Winifred J.; and Bell, Marjorie: The Influence of Improved Prenatal Nutrition Upon the Infant. *The Canadian Medical Association Journal*, 1942, 46, pp. 6-8.

groups received the same care after they left the hospital, yet, as can be seen in Table 5, the record indicates that the babies from the poorly fed mothers had many more colds than the babies of the mothers who were well fed.

The babies of poorly fed mothers had a higher proportion of each of the principal illnesses occurring during the first six months of life than did the babies of well fed mothers. For bronchitis the percentages were 4 and 1.5, for pneumonia 5.5 and 1.5, rickets 5.5 and none, tetany 4 and none, dystrophy or difficult feeding babies 7 and 1, and anemia 25 and 9.

The most striking results of the whole study are shown in Table 6. There were 14 babies lost, 7 from miscarriages, 4 from stillbirths, 2 from pneumonia, and 1 from prematurity. Every baby lost came from the mothers who were poorly nourished.

This study is evidence that a diet that is not optimum, although still good enough not to produce any clinical conditions which could be recognized, interfered with the efficiency of these women.

Table 6. Miscarriages and infant deaths.

	Quality of Diet		
	Poor Diet	Supplemented—Good	Good Diet
	Number		
Total Patients	120	90	170
Miscarriages	7	0	2
Stillbirths	4	0	1
Deaths: Pneumonia	2	0	0
Prematurity	1	0	0
	14	0	3
Congenital Malformations	1	3	2
Prematures	9	2	5

They were not as efficient as they should have been in producing healthy, normal children under this period of stress and strain.

Now the next subject to be considered is the effect of diet on growth. Back in 1926 in England, Corey Mann (4) and in 1928 Sir John Boyd Orr (5) showed that the administration of extra food at noon markedly increased the rate of growth as measured by height and weight of children. In 1930, Agnes Fay Morgan (6) showed that the giving to one group of children of a biscuit or muffin containing a large amount of wheat germ resulted in a more rapid rate of growth.

The records of the University of Toronto freshmen show that 1,000 freshmen of an average age of 19 years, examined in 1920-1921, had an average height of 5 feet 8 inches and an average weight of 138 pounds (7). Seventeen years later, in 1937, in a similar group of the same age, there was a gain in height of 1.5 inches and a gain in weight of 5.2 pounds. One cannot say definitely that this is due to better diet, but better diet is the one marked change that has occurred in those twenty years.

Similar results were obtained in another study in Toronto (8) where 78,000 Toronto school children were measured in 1939 and compared with the measurements taken on 48,000 school children in 1923. The child in Toronto in 1939 was the same height and weight as a child one and one-half years older in 1923; that is, at the age of 9.5 years in 1923, the school child of Toronto was the same height and weight as a school child today is in Toronto at 8 years of age. Again, this study furnishes indirect evidence that better nutrition affects the rate of growth.

Another study shows some work that was done at the Hospital for Sick Children in 1932 (9). Dr. Summerfeldt took a group of children at an orphanage who were fed a very good diet. The diet included, among other things, twenty-four ounces of milk a day; one ounce of butter; meat, three to five times weekly; eggs, one to seven weekly; potatoes and one or two other vegetables daily;

and fruit throughout the year. The children had a reasonably good diet.

Two groups of these children were taken. One continued on the regular diet of the institution and the other group, in addition to the regular diet, was fed daily a vitamin B complex in the form of a concentrate made from wheat germ and brewers' yeast, which weighed only six grams, a very small pill. The rate of gain of the control group is essentially the expected rate, yet the children who were fed the vitamin B complex grew much faster. From this study one can conclude that, taking a diet that is already fairly good, that diet can be improved and the children with the improved diet grow larger and heavier than they otherwise would. Diet has a profound effect on growth.

As to the effect of infection on one's resistance to disease, there are many hundreds of references in the literature. The only study which will be referred to is the work done at the Hospital for Sick Children in Toronto (10).

Dr. Elizabeth Chant Robertson at the Hospital for Sick Children took animals and divided the litter mates into two groups. One group received a diet lacking in the food substance to be tested; it was not completely left out in many instances, but it was reduced. The litter mates received the same diet, but the missing element was present in optimal amounts. After the rats had been on these respective diets for a certain length of time, they were then given a measured amount of disease-producing organism, Salmonella muriotitus, and the number of survivors noted. The results are shown in Table 7. When the diet was lacking in vitamin A, 40 per cent of the animals survived compared with 79 per cent of those on an adequate diet.

In another year, using different dosages, because the dosages had to be regulated very carefully—if you gave too large a dose you would kill all the animals; if you gave too small a dose they would all live—when the B complex was reduced, 20 per cent survived as compared to 72 per cent surviving when the diet was perfect. When vitamin D was lacking in the diet, 28 per cent survived as compared to 55 per cent of the litter mates that were on the perfect diet. When the minerals were low, 54 per cent survived as compared to 87 per cent when the diet was perfect. When the animals got their protein, all from sources other than animal proteins, 40 per cent survived as compared to 90 per cent when there was some casein added to the diet.

In this one table there is evidence that almost any one of the thirty-odd food substances necessary for life, if reduced in amount, will lower resistance against infection.

Now in regard to physical strength and vigor, Dr. Russell M. Wilder reported in May 1942 (11) that when individuals on a diet low in thiamin had thiamin restored to the diet, the measured capacity for physical work was doubled.

In the fall of 1942, the work from the Harvard Fatigue Laboratory (12) came out along these same lines, as did also the work of Dr. Ivy and his coworkers in 1943 (13).

A summary of some of the work from the Harvard Fatigue Laboratory is as follows:

"Over a period of five days, men receiving a diet lacking in all mem-

Table 7. Effect of improper nutrition on resistance to infection.[1]

Food Substances Deficient	Number of Animals	Survivors on Deficient Diet	Survivors on Adequate Diet
		Per Cent	
Vitamin A	24	40	79
Vitamin B	151	20	72
Vitamin D	739	28	55
Minerals	124	54	87
Animal Protein	81	40	90

[1] Ross, John R. and Robertson, Elizabeth Chant: The Effect of Vitamin B Complex on the Resistance of Rats to Enteritidis Infection. *American Journal of Diseases of Children*, March, 1932, 43, p. 547.

bers of the B complex showed deterioration in capacity for easy work. The men receiving thiamin remained normal in this respect." In other words, if all the B complex was reduced, on easy work the men showed deterioration, but if they got thiamin they did not. "For exhausting exercise, there was a progressive, marked deterioration in the fitness of both groups." This again illustrates the effect of strain.

"The daily administration of 18 grams of dried brewers' yeast resulted in a complete return to normal in both groups in five days, the thiamin group improving more rapidly."

"A lack of thiamin results in symptoms of lack of well-being, irritability, muscle pains, and moderate impairment of physical efficiency. A lack of the other members of the B complex is characterized by few symptoms, but by marked impairment of capacity for hard work."

Poor diet can definitely affect the mental outlook of individuals. Wilder first brought to our attention the effect of a low thiamin intake on mental reaction; he found that individuals on a low intake of thiamin became irritable, morose, and were upset with little things.

In the study of pregnant women made in Toronto, one of the first evidences of change that was observed in the women when their diets were improved was a change in their mental outlook. Before improvement of their diets they were worried about everything, the whole business was a trouble to them, housework bothered them, they were unhappy; when they came back after three weeks on a good diet their faces were washed, their hair was brushed; if they could get a new feather they stuck it in their hat. As Sir John Boyd Orr remarked, "Don't forget, a woman during the child-bearing age who is not interested in her appearance has something wrong physiologically." These women became definitely interested in their appearance.

In regard to the effect of diet on learning ability, Mauerer and Tsai (14) in 1930 showed that if you took newborn rats and had them nurse for three to four weeks from mothers who were receiving a diet lacking in the vitamin B complex, these young rats did not learn as rapidly as their litter mates or other rats that had received a perfect diet.

Table 8 shows the results of a similar study done in 1934 by Bernhardt at the Hospital for Sick Children in Toronto (15). This study was essentially repeating the work of Mauerer and Tsai, except that instead of a maze with food as a reward, a maze with getting out of water as the reward was used, and the rats had to learn to go through the maze. Half of them were on a vitamin B complex deficient diet for the first four weeks of life. Then they all went on a perfect diet and at four months of age the deficient rats were almost the same weight and had the same physical appearance as the control rats. Yet, when these rats had reached four to six months of age, which would correspond to about ten years of age in the human life, and were tested as to their ability to learn to go through the maze, a striking difference was noted. As shown in Table 8, the control group learned to go through the maze on an average of twenty-eight trials; the B deficient rats took forty trials. The average time required for the control group was 1,289 seconds; the deficient rats took 1,705 seconds. The average errors were 141 as compared to 201. The average retraces; that is, where the rat goes into the wrong part of the maze and has to go out again, were 26 against 33. The excess

Table 8. The effect of Vitamin B Complex during nursing on subsequent learning in the rat.[1]

	Maze Scores	
	Control	B. Deficient
Average Trials	27.8	39.8
Average Time in Seconds	1,289.3	1,705.2
Average Errors	141.1	200.7
Average Retraces	26.4	33.2
Excess Distance	357.2	495.0

1 Bernhardt, Karl S.: The Effect of Vitamin B Deficiency During Nursing on Subsequent Learning in The Rat. *Journal of Comparative Psychology*, 17, No. 1, February, 1934.

distance traveled was 357 as compared to no less than 495 in the B deficient rats. In other words, a lack of vitamin B complex during early childhood of these rats impaired their ability to learn when they were at the comparable age of 10-year-old children in the human scale. In brief, these rats were stupid.

The most recent work with humans is that of Miss Harrell (16), who took children at an orphanage and divided them into two groups. It was estimated that the average intake of thiamin of the children at the orphanage was .9 mg. daily. One group was given a placebo. The other group was given 2 mgs. of thiamin which gave them a total of 2.9 mgs. Then the children, 37 in each group, were most carefully tested as to their learning ability by means of 18 different tests. At the beginning of the study there was no essential difference between the two groups, the A group and the B group, as to their relative standing in all of the 18 different tests which combine both mental tests, such as addition, subtraction, multiplication, and so on, with physical tests, such as throwing darts, balls, and strength of the hands.

After six weeks, in each of the 18 tests, the B group getting the 2.9 mgs. of thiamin had gained much more than the control group that was getting .9 mg. The requirements for these children, who ranged from 9 to 19 years of age, would vary according to the National Research Council standards, from 1.2 to 2. I am sorry that this figure of .9 was a calculated figure and not an actual assay figure, because we have found from experience in the Royal Canadian Air Force that calculated figures sometimes bear little resemblance to the actual figures after the food has been cooked. I would suspect that this figure of .9 might be a little lower, but in any case it was considered a good diet in this institution, yet when they got an adequate amount of thiamin their learning ability was much greater than when they did not. The increase was 27 per cent greater in the group receiving the additional thiamin. This is very striking indeed.

Definite psychiatric changes can develop as a result of dietary deficiencies. The work of Wilder, Jolliffe, and Sydenstricker, particularly in regard to older individuals where marked psychiatric changes are present, has demonstrated that these changes respond dramatically to the administration of adequate amounts of niacin.

Then we come to the effect of weather, the stress and strain of extreme heat and extreme cold. Studies have been made on Indians in northern Canada, who in addition to having diets that are markedly deficient in many respects are exposed to cold and tremendous glare from the reflected light from the snow. In addition, their lives demand extreme exertion. Marked pathological changes were noted in many tissues, including the eyes, and it would appear that the climatic conditions greatly aggravated these changes.

Twenty-five years ago Professor McCollum (17) fed animals wheat, corn, vegetables, potatoes, peas, beets, turnips, and dried beef, a diet not far different from any diets used throughout the world in certain places today. Animals at ten months of age, comparable in the human life to between 18 and 20 years, had all the appearance of old age.

It is true that the diet fed these animals was not very good; but that diet is being used today in certain parts of the world.

Sherman's work (18), reported in 1930, will illustrate the effects of a diet that is good. He took a diet (Diet A) that was already good and consisted of a mixture of one-sixth dried whole milk and five-sixths ground whole wheat, table salt, and distilled water. Families of experimental animals, rats, were still thriving at twenty-one successive generations on this diet.

Diet B had the proportion of milk powder in the food increased to one-third. The two groups of animals were of the same heredity and were kept under identical conditions.

On Diet A the rats lived an average of 590 days, while on Diet B they lived an average of 654 days, an increase of 64 days or 10 per cent. From further investigations it seems probable that the increased intakes of calcium, vitamin A and of perhaps B_2 all have contributed to the higher degree of health and the increased length of life. The most significant conclusion is as follows: "Hence, it may be regarded as established beyond any reasonable doubt that starting with a diet which is already clearly adequate, it may still be possible to induce a very significant improvement in longevity by enriching the diet in certain of its chemical factors."

I have attempted to take you from before birth right through life to show you how a diet that is not adequate in all respects but still does not produce any well-marked clinical entities can affect the health and efficiency of the individual. It was in 1877 that Disraeli said, when he was then Prime Minister of England: "The health of the people is really the foundation upon which all our happiness and all our powers as a state depend." And there is no one factor which so affects the health of the people as the food they eat.

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