THE EFFECT OF A SUPPLEMENTARY SCHOOL LUNCH ON NUTRITIONAL STATUS AND HEMOGLOBIN LEVEL

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INTRODUCTION

There have been many attempts to improve the nutritional status of young school children through the feeding of lunches supplementing the regular home diet. The presence of dental caries, infected tonsils, mild anemia, enlarged thyroid, enlarged lymph glands and defective vision may be in part attributed to the lack of an optimum diet; and although these defects do not necessarily impair nutrition, they are undoubtedly a factor in malnutrition.

When supplementary lunches for undernourished school children were first instituted, milk was the food usually given. While milk generally gave satisfactory results, other foods have also been shown to be satisfactory.

REVIEW OF LITERATURE

Chaney (6) compared a mid-morning lunch of milk and graham crackers with orange juice and graham crackers during two eight-week periods and found slight gains in weight in both groups; but the children in the latter group made a slightly larger gain. This study was later continued by Morgan and her co-workers (29, 30, 31) by observations on small groups from the Deaf and Blind school, a junior high school and a public school. As before, the children benefited from the lunch whether it consisted of milk, oranges, figs, crackers or wheat germ biscuit. In the first institution oranges gave the largest gain in weight, while in studies with children from low income families the largest gains resulted from milk or crackers. In the last study the children fed a wheat germ roll for thirty weeks showed a gain in weight three times that of the controls. The authors conclude that a definite superiority for any particular food cannot be assumed, and that choice of such lunch should be made only after careful consideration of home diets.

A special cereal was used by Summerfeldt in a study on twenty-one children who were patients in a hospital (49). At the end of a ten-week period she found the group receiving the cereal had gained 3.57 times the expected rate of gain while the control group had gained only 1.17 times. Hemoglobin values for the special cereal group were raised 1.5 gm. while those of the ordinary cereal group were raised only 0.9 gm. The gain in weight was attributed to the vitamin B_1 content of the cereal and the increase in hemoglobin to the iron content. In a continuation of this study (50) the authors conclude that the rise of hemoglobin was not due, except in a minor degree, to the vitamins B_1 and B_2 present in the cereal, for ingestion of these factors alone was followed by only a small rise in hemoglobin. When vitamin B_1 and B_2 concentrates were given (44) for a period of six months there was an increase of 0.9 gm. in the hemoglobin value and 1.6 times the expected gain in weight, while with the special cereal alone there was a gain of 1.8 gm. in hemoglobin value and 2.3 times expected gain in weight. When this was continued (51) for twelve and eighteen months similar results were obtained.

Wait, Merriam and Cowing (53) found a definite though not marked improvement in children whether fed milk or tomato juice as a supplementary lunch. This was judged by medical records, gain in weight and improvement of the "general" nutritional condition. The study was carried on 760 rural school children extending over a period of four years.

Roberts et. al. (43) made a very comprehensive study for one year on 107 children in an institution where an accurate check on the daily diet could be made. They compared the value of irradiated and non-irradiated evaporated milk as a supplement to the usual diet with a control group and found the average excess in mean gain of weight over the control group was 2.27 pounds for the non-irradiated milk group and 1.4 pounds for the irradiated milk group. Comparison of the two groups was also made by roentgenograms of the wrists and a dental examination.

It was customary until recent years to assume that vitamin B was widely distributed in natural foodstuffs and that any reasonably well-constructed diet was likely to contain enough of this vitamin. With the discovery of the multiple nature of this vitamin, however, this theory is not well substantiated. Since vegetables and fruits are not excellent sources of vitamin B_1 and with the increased use of highly milled products, the modern diet may be lacking in this vitamin.

Recent studies have indicated an increased vitamin B_1 ingestion is frequently beneficial to infants and children, and that the amount included in ordinary diets may frequently be less than the amount required for optimum health. Knott (20) obtained higher retentions of vitamin B_1 with higher intakes for each level of ingestion studied and concluded the optimum requirement for young children is 40 Chase-Sherman units per kilogram per day. This is about six times the calculated minimal requirement. A continuation of this study was carried on by Schlutz and Knott (47) with fifty-four children over a thirty-two week period. The regular diet of the institution averaged 260-420 international units of vitamin B_1 per day while the supplements of wheat germ and crystalline vitamin B_1 furnished 120-200 additional units. The supplementary ingestion of 150 units produced from 17-25% increase in the grams of food consumed per child per day. They conclude that since the higher levels of vitamin B_1 administered during this investigation produced no apparent ill effects, did not force the growth, and did tend to stabilize the appetites of the children, the higher ingestions of vitamin B_1 may be regarded as optimum.

Unless the food intake is known, a deficiency of this vitamin is difficult to determine since no generally accepted symptom, sign or diagnostic test of vitamin B_1 deficiency in humans exists (60). Hoobler (21, 22) in studying infants, found anorexia to be one of the first signs of a lack of vitamin B_1 in the diet and a loss of weight or a period of stationary weight another symptom. The addition of vitamin B_1 to the diet caused an increase in growth not only because the appetite was stimulated and thus increased the food intake, but the same effect was noted even when the intake of food remained the same. This would indicate that vitamin B_1 in addition to having stimulated the appetite may also have brought about a better assimilation and utilization of the food intake. He concluded that the quantity of vitamin B_1 needed by infants differs greatly and that the vitamin B_1 in commercial products may be sufficient for certain infants and not for others. Ishii (23) found the addition of purified vitamin B_1 to the normal diet of children slightly increased the rate of growth.

With the addition of a water-soluble extract of rice-polishings to an evaporated milk formula, Poole, et. al. (40) found a greater regularity of growth in infants studied from week of birth to one year. The average hemoglobin level for the infants receiving the vitamin B_1 supplement while not higher than the control group, did seem to be more constant after the first customary initial drop in the first few weeks. The authors conclude this demonstrates the possible stabilizing effect of vitamin B_1 on growth and nutrition.

Sauer (45) studied fifty-two children from a few weeks to fourteen years of age, all in fair condition, but most of them with some definite complaint. They received one to two teaspoons three times a day of levurinose, a brewer's yeast powder, as a source of vitamin B complex. Observed over varying periods, 58% showed a small increase in reticulocyte percentage, 27% a decrease and 15% no change. Certain cases showed a reticulocytosis after fourteen days, suggesting that the vitamin B complex, besides causing a mobilization of pre-formed young red cells from the marrow, may also induce regeneration of young cells.

A review of literature reveals a paucity of material on the normal hemoglobin standard for children between five and fourteen years of age. The hemoglobin value is highest at birth, then rapidly declines until the minimum is reached at about one year. After the second year it rises at a fairly rapid rate with sudden increases between six to ten years and from sixteen to twenty years. At this age, it reaches the adult level and from twenty to fifty-five years the variations in different age periods are very slight (57).

"So few are the reliable observations of the hemoglobin content of the blood during infancy and childhood that it would seem unwise to make a more precise statement concerning the average values and the normal limits of variation for the different age groups..... The important values are not the averages, but the average limits of variation. It is just these which are particularly uncertain" (55). This quotation from the report of the White House Conference on Child Health and Nutrition indicates clearly the need for the study of normal hematologic standards in children.

This study was undertaken to show the nutritional status, and hemoglobin values of the blood of school children as affected by the feeding of a supplementary lunch of two vitamin B_1 wafers* which each contributed 100 international units per day. The school was divided into two groups, one receiving the supplement and the other acting as a control group.

*The writer is indebted to Hilker and Bletsch Company of Cincinnati, Ohio for contributing the wafers for this study.

Children Enrolled in Towargarden School

1938 -'39

EXPERIMENTAL PROCEDURE

With the assistance of the Ingham County Health Service permission was obtained from the school board of Towargarden district to conduct the experiment in their school which is located four miles northeast of East Lansing. There were fifty-two children enrolled in the school all of whom were distributed through a primary class and the first three grades as shown in Table 1. However, only forty-eight of the children were included in this study.

Table 1. Distribution of Children

According to Sex, Grade in School and Age

	Primary	1st Grade	2nd Grade	3rd Grade	6 yr.	7 yr.	8 yr.	9 yr.	10-12 yr.
Boys	7	5	7	3	4	5	6	4	3
Girls	10	6	6	4	6	8	9	3	0
Total	17	11	13	7	10	13	15	7	3

Before the study was begun, a physical examination was conducted by Dr. C. D. Barrett and Dr. E. F. Hoffman from the Ingham County Health Service. At this time a plan of the study was presented to the parents and in all cases consent was given for the children to participate in the problem.

The study was begun on February 13 when seven anthropometric measurements were made on each child. Height, weight, arm girth, chest breadth, chest depth, hip width and subcutaneous tissue were measured. Due to the cold weather at this time, many of the children were dressed in heavy clothing. When the measurements were being taken, all sweaters or jackets were removed and the measurements carried out over as little interfering clothing as possible. Weight was taken without shoes, on the school scales which weighed accurately to one-half pound. Height was obtained by means of a wall measuring chart which read accurately to within a quarter inch. In making the other anthropometric measurements the technique as suggested by the American Child Health Association (2) was followed. A steel tape equipped with a Gulick spring handle was used for measuring arm girth; a large sliding wooden caliper for measuring chest depth, chest width and hip width, and an especially devised caliper for subcutaneous tissue. Data for all physical measurements, recorded by a second worker, were put down in table form (Table 2) for ease in determining nutritional indices. The nutritional indices of arm girth, weight and subcutaneous tissue were determined from tables published by the American Child Health Association (2).

While the physical measurements were being made, a conversation was carried on with each child in an effort to gain information about his dietary habits. Such general questions as, which foods he liked and disliked, if he got up in time for breakfast and whether or not he drank milk were asked.

Having obtained some information about the nutritional status of the group as a whole from the doctor's examination and the various physical measurements, an attempt was made to divide the children into two comparable groups. Sex, age and physical status were considered in as many instances as possible so that the experi-

Table 2. Score Card for Computing
Nutritional Status Indices

Name____Sex______Age____________

School________________________Room__________Grade_____Date____________

MEASUREMENTS

Arm Girth	Flexed	a	c..................
	Relaxed	b	
Subcutameous Tissue over the Biceps		d	f..................
		e..............	
Weight			g..................
Height			h..................
Chest Breadth	Expiration	i..............	k..................
	Inspiration	j..............	
Chest Depth	Expiration	l..............	n..................
	Inspiration	m..............	
Width of Hips			o..................

	COMPUTATION OF INDICES					
	Arm Girth		Sub. Tissue		Weight	
	+ Value	− Value	+ Value	− Value	+ Value	− Value
Measure						
Height						
Chest Breadth						
Chest Depth						
Hip Width						
Adjustment for age						
Sums	+	−	+	−	+	−
Indices						
No. in 1,000 with smaller indices						

mental group would be quite comparable to the control group.

Two kinds of small wafers were fed, one to which 100 international units of vitamin B_1 had been added by the incorporation of thiamin chloride, and the other similar except that no vitamin concentrate had been added. The cookies were taken out to the school and the teacher, Mrs. Hankinson, kindly distributed the wafers to each group during recess time, so that each child in the experimental group received two wafers daily during the five school days each week or a total of 200 international units of vitamin B_1 five times a week. The control group received their two wafers daily also but they contributed no food essential to their diet.

Hemoglobin determinations were taken at the beginning of the study using the Newcomer method of analysis (26). The doctors, who were assisted by the school nurse, obtained blood samples from the ear. It was found in many cases that very small amounts of blood were obtained in this manner and it was necessary to massage the ear to get a sufficient amount of blood, or in some cases the finger was used. In later tests, after the children became more familiar with the procedure, the finger was used entirely.

After the samples had been obtained on the entire group they were taken to the research laboratory at Michigan State College for reading. All readings were completed within twenty-four hours from the securing of the sample, a time well within the length of time shown by Newcomer (26) to insure no change in color. Ten readings were taken on each sample and averaged; this was repeated and an average of the two sets of readings was used. However, if these two sets did not check within 0.5 mm, a third average was obtained. Hemoglobin values were determined at intervals of approximately a month during February, March, April and May. At the close of the school year, May 12, the seven anthroprometrical measurements were made again, and a second physical examination was made by the doctors. These data were used to calculate the three nutritional indices, arm girth, weight and subcutaneous tissue.

The week following the closing of school, a home visit was made to each family to tell them the results of the study, and to secure more information about the home diet of the child whenever possible.

The hemoglobin data were subjected to statistical analysis andthe following measures determined: mean, median, standard deviation, probable error of the mean and coefficient of variation. These computations were made on average hemoglobin levels and a comparison made between the children receiving the vitamin B_1 wafer and those receiving the plain wafer.

DISCUSSION AND RESULTS

Part I: Hemoglobin Levels

From a careful survey of the literature a summary of hemoglobin values of the blood of children in similar age groups as those included in this study is presented in Table 3.

Table 3. Average Hemoglobin Readings of Children 4 - 15 Years of Age.

Author	Age of Subjects	Number of Subjects	Number of Determinations	Average Hemoglobin Level (grams)	Method
Williamson	5-15 yr.	105	105	14.14	Spectopometric
Wilke	5-15 yr.	200	312	13.44	
Osgood & Baker	4-13 yr.	215	215	11.96	Osgood-Haskins
Summerfeldt & Ross	5-14 yr.	66	132	11.00	Newcomer
Mugrage & Andresen	5-14 yr.	299	299	13.77	Osgood-Haskins

The range of hemoglobin values in children from 4 - 15 years old found by these workers varies from 11.00 to 14.14 grams per 100 cc. of blood. In most of the cases the results are based on single readings which might vary somewhat from the true value, depending upon many factors which have been shown to cause the hemoglobin value to be increased or decreased as much as 15 to 25 percent (41,54).

Table 4. Number of Children, Average Hemoglobin Levels and Statistical Evaluation for Experimental and Control Groups

Division of Groups	No. of children	Range	Median	Mean	S.D of Mean	P.E. of Mean	Coef. of Var.	% of cases between 11.50-14.50 gms.
		(gms.)	(gms.)	(gms.)	(gms.)	(gms.)	(%)	(%)
Children receiving vit. B_1 supplement	24	11.49-17.75	13.28	13.97	1.40	0.1893	10.4	80
Children not receiving vit. B_1 supplement	24	10.70-16.76	13.17	13.36	1.28	0.1730	9.6	80
Average of two groups	48	10.70-17.75	13.21	13.41	1.34	0.1293	10.0	80

A summary of the hemoglobin values found for the children in this study and a statistical analysis of the data are shown in Table 4. Four readings at intervals of one month, the first begun in February and continued through into May, were made but due to absences from school four readings were obtained on only twenty-one children, three readings on twenty-two children and two readings on five children.

The table shows an average of the four monthly hemoglobin readings on the forty-eight children to be 13.41 grams which is within the range for children of this age as reported by Mugrage and Andresen (32), Williamson (57) and Wilke (56). The hemoglobin value for the children receiving the vitamin B_1 wafer was 0.61 grams higher than that for the control group, a small difference probably not large enough to be statistically significant.

There is no appreciably large difference between the two groups to conclude that the addition of vitamin B_1 to the diet increased hemoglobin formation. This is in accord with Summerfeldt's (48) conclusion that the increased vitamin B_1 played little part in the determination of the level of hemoglobin in the blood.

The figures for both boys and girls in this study have been grouped together as variations in hemoglobin due to sex, up to the sixteenth year, have been found by Wilke (56) to be slight and may, for all practical purposes in this study, be neglected. The average value of the boys in the present study was 13.40 and the girls 13.43 grams, a difference which can be disregarded.

Pickard states of the routine tests used in clinical diagnosis the estimation of hemoglobin is one of the most indefinite (38). The methods used have wide individual errors besides those of technic, such as unnecessary errors in the manufacture of the instrument. There is also a justifiable uncertainty as to the normal standard. Wintrobe (58) feels the knowledge of hemoglobinometry has been hampered by the inaccuracy and inadequacy of hematologic technic. Advances have been further impeded by lack of sufficiently well founded standards of the normal. Elvehjem (10) and several other workers early advised basing the standard on grams of hemoglobin per 100 cc. of blood instead of on a percentage basis. This was slow to come but is now almost universally used.

Holiday (19) feels that in spite of the many investigations which have been made on blood, the following statements can scarcely be disputed: (1) the amount of hemoglobin in a given volume of blood cannot be accurately estimated (2) the percent of hemoglobin relative to a "normal" standard is accurate only for the apparatus employed and differs widely with different instruments. Different results were obtained with the same instruments when read by two observers. He also found differences in color shades easy to read in the lower parts of the scale but obscure in the higher parts where a slight difference in shade represented an appreciable range of hemoglobin concentration. Readings were easier to make in daylight than by artificial light.

Alt (1) found it possible to check with greater accuracy when using the Newcomer or Sahli instruments. The Newcomer was usually read within 1-2% error; however, there were occasional blood specimens that had variations up to 10%. The normal for male adults using the Newcomer instrument is 16.92 grams per 100 cc. of blood which is taken as 100%. This is lower than Sahli and Von Fleischl-Meischer but higher than Dare, Haldane, Oliver and Tallqvist.

In addition to the errors of the instrument and technic there is a wide range within which a normal reading may fall because of the many factors causing a variation in the hemoglobin value.

The blood samples for this study were taken throughout the school day thus hourly variations in hemoglobin values have not been taken into consideration. Rabinovitch (41) took blood samples every two hours on twenty individuals and found that the hemoglobin value varied as much as 26% in two cases; 15-20% in four cases and 10-15% in six cases. While Ward (54) found 17% and 26% variance in hourly tests on two normal subjects. Mills (28) working with anemic patients found a range of 5-20% between hourly values. These tests showed the hemoglobin value to fall during the day and rise at night since the highest readings were found during 9-10 a.m. and the lowest 6-7 p.m.

The question of the effect of seasonal variation would seem still unsettled. Osgood (34) found no seasonal variation in hemoglobin values, while Platt and Freeman (39) found a definite seasonal variation with the lowest values occuring during the winter months, followed by a rise in May and a peak during the summer months. The lowest values occurred during the time of greatest incidence of upper respiratory infections. In this study the highest average value was found in March. The following month showed a slight decrease in average hemoglobin values perhaps explained by the fact that there was a flu epidemic and also by the fact that many of the children had contracted contagious diseases.

Smith (48) found no variation in hemoglobin value in response to rest, moderate activity or food. However, Schneider and Havens (46) and Boothby and Berry (4) found that after subjects had been submitted to various forms of exercise there was an increase in the hemoglobin value ranging from four to eleven percent. In this study it was necessary in some instances to take the blood samples just after the children had been playing hard at recess time or after the noon hour. Following such conditions the hemoglobin values may have been higher than would have been found under ordinary conditions.

The data may be vitiated somewhat by the manner in which the blood was taken. Several workers report there should be no undue manipulation that involves "milking" in trying to force enough blood to the surface. Bing and Baker (3) state that this may cause surprisingly large errors and, contrary to what might be supposed, the errors usually lead to high rather than low values. However, since these tests were made in a one room school house while school was in progress, it was necessary to take them quickly and with as little disturbance to the subject as possible. Hence it was difficult to secure blood samples without being tempted to squeeze the surrounding tissues.

In the statistical analysis (Table 4) it will be noted that the range in average hemoglobin levels was 7.05 grams while Osgood and Baker (35) reported 5.03 and Wilke (56) 3.39 grams. However, 80% of the cases fell within a range of 3 grams (11.50-14.50 gms.) which is about the same percentage as that reported by Goldhammer and Fritzell (13), Wintrobe and Miller (59), Osgood (33), Osgood and Haskins (36) and Elvehjem and co-workers (9). This shows there were only a few cases at either extreme.

The standard deviation for the group receiving the supplement was 1.40, for the control group 1.28 and for the entire group 1.34. The observed minima and maxima (10.70-17.75) and the calculated minima and maxima by 3 S. D. (9.39--17.43) are essentially in agreement, so that the group as a whole may be considered homogenous.

The probable error of the mean for the experimental group was 0.1393, for the control group 0.1730, and 0.1293 when considering all of the cases.

The coefficient of variation for the children receiving the supplement was 10.4%, for those not receiving the supplement 9.6%, and 10.0% when both groups were included. This shows the hemoglobin levels of the two groups had about the same amount of variability. The values representing the children who received the vitamin B_1 wafer show a slightly larger variation than was true for the control group.

In all the statistical analyses on the hemoglobin levels for the group receiving the vitamin B_1 wafer and for the control group there were probably no differences between the two groups large enough to be considered statistically significant.

Part II: Nutritional Status

The trend in change of weight for the forty-eight children is shown in Table 5. A record of previous monthly weights was secured from the teacher and included in the table in addition to those weights obtained during the study. Four months out of the school year were chosen to show the variation in average weights. The individual weights for the children of different ages varied from thirty-three pounds to eighty-two pounds so this average weight does not give a picture of the group but rather just shows the trend of the whole group.

Both the experimental group and the control group show a practically stationary weight or slight loss in weight in the fall and winter months and an increase in the spring months during this study. The children in the control group showed a slightly higher average weight for all the months which shows the children in this group as a whole were probably closer to normal weight.

Table 5. Trend in Gain or Loss of Weight as Shown by Average Weights of Groups

No. of Children and Kind of Supplementary Lunch Received	Average Weights of Group			
	Sept. (lbs.)	Nov. (lbs.)	Feb. (lbs.)	May (lbs.)
Average weight of 24 children receiving vitamin B_1 wafer	47.9	47.6	48.9	49.1
Average weight of 24 children not receiving vit. B_1 wafer	49.2	49.3	50.2	50.7
Average weight of 48 children from both groups	48.6	48.5	49.6	49.9

Even though an attempt had been made to match the two groups before the supplementary feeding was begun, it was found in analyzing the data at the end of the study there was a distinct difference in the make-up of the two groups. At the beginning of the experiment 70% of the children in the experimental group were below their expected weight (Table 6) while in the control group only 48% of the children were below their expected weight.

Table 6. Percentage of Children Varying from Expected Weight at the Beginning and End of Study

Period of Study	24 children receiving vitamin B_1 wafer		24 children not receiving vitamin B_1 wafer	
	Above Exp. weight (%)	Below Exp. weight (%)	Above Exp. weight (%)	Below Exp. weight (%)
Beginning of study	30	70	52	48
End of Study	25	75	40	60

At the end of the three months period the children who had received the vitamin B_1 wafer showed what would seem to be a beneficial effect from the additional vitamin B_1. At any rate the children in the supplemented group seemed to show more stability; there were fewer failures to gain and the children seemed better able to "hold their own". At the end of the study the control group showed a 12% increase in the percentage of cases losing weight while the supplemented group showed only a 5% increase.

There was no very striking improvement noted in either group mainly because of the season in which this study was made. This tendency for a stationary weight or loss in weight in the spring is in accord with findings of other workers as to effect of seasonal variation. Emerson (11) found gains in weight to be lowest from January to May and highest from July to November. He states: "A child who fails to gain in weight each month, at least up to the age of ten years, is in all probability suffering from some sort of infection or fatigue in which diet and housing play important contributing parts".

Roberts (43) in summarizing studies made by several workers draws the conclusion that for the majority of children maximum gains occur in the latter half of the year. For this reason she suggests that analysis of school data be on a calendar year rather than school year basis. The cause of seasonal variation is not yet determined, but probably there are many contributing factors such as sunlight and temperature, hygienic factors and the incidence of disease.

The expected weight of a child is usually based on height, age and sex. Palmer (37) believes growth in weight is more dependent on weight attained than chronological age. Thus he points out that the gains of ten year old girls vary from five to fourteen pounds per year depending on whether the girls weigh fifty or ninety pounds at that age.

Turner and Norstrom (52) tried three methods for screening out children who needed health improvement. They found that a record of intermittency of growth for a three month period gave the truest picture. Height--weight--age tables have a tendency to screen out children who are naturally small for their age while the intermittency method does not. Table 7 shows the results of subjecting the weights of the children in this study to such an analysis.

Table 7. Percentages of Children Who Failed to Gain Over a Three Months Period

No. of children and kind of groups	Percentage of children failing to gain in -						
	Sept.-Dec.	Oct.-Jan.	Nov.-Feb.	Dec.-Mar.	Jan.-Arp.	Feb.-May	Mar.-June
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
24 children receiving vitamin B_1 wafer	33	15	11	15	15	4	6
24 children not receiving vitamin B_1 wafer	23	18	6	10	29	13	4
43 children total of both groups	56	33	17	25	44	17	10

In this study in the spring months there was a smaller percentage of those who failed to gain than in the fall and winter months which is contrary to the results found by Turner (50). Probably due to the difference in the make-up of the two groups as shown in Table 5, there was a larger percentage of the experimental group who failed to gain in the fall and winter, but after the additional vitamin B_1 was given to this group the percentage became smaller than that for the control group and remained so except for the last period. This may indicate an increased food intake or increased food utilization due to the vitamin B_1 incorporated in the diet. This analysis shows further the constancy and improved condition of the experimental group by these smaller percentages of failures to gain.

The assumption that weight varies with body build as well as with stature seems logical. Franzen (12) emphasized the importance of skeletal dimensions in determining weight, and of the size of muscles and the amount of subcutaneous tissue as indicating the nutritional status of children. He found that the correlation of height with weight was much lower than that of other skeletal measures with weight, and pointed out that to base nutrition conclusions on weight-height ratios may cause great errors because of hip and chest variations.

Seven anthropometrical measurements were made on the children in this study: weight, height, arm girth, chest depth, chest breadth, width of hips and subcutaneous tissue. Anthropometry has grown the last few years with the availability of new statistical instruments of research. The chief fault of the older anthropometry was that it failed to take account of innate individual differences of build, except that of height, and insisted that all persons of a given sex, age and height should be alike otherwise. The new anthropometry recognizes the validity of hereditary individual differences and through the use of proper structural and functional measurements, offers a more valid method of appraising with a fair degree of accuracy the physical status of the individual.

Even with the improvements on these instruments however, there is still a great chance for error in technique because handling of the instruments necessitates the subjective judgment of the operator. The most comprehensive studies made on the use of anthropometric measurements are reported by Boynton (5) and Meredith (27). They did not use the same measurements as were used in this study so no analogies can be made. However the magnitude of the error in measurements due to subjective factors was shown in large standard deviations for some measurements and wide ranges for all measurements at all ages.

Three nutritional indices including arm girth, weight and subcutaneous tissue were computed using the table of the American Child Health Association (2). These indices show the individual child's standing among other children of his age, sex and skeletal build. Since much change in skeletal development could not be expected from such a short study and since there is a possibility for subjective error in measuring technique, the measurements of each child for February and for May were averaged. The nutritional indices were based on this average. Tables are worked out only for boys and girls between seven and twelve years of age so only thirty-seven of the forty-eight children could be included in this analysis. Table 8 shows the distribution of the children on a percentage basis for the three indices.

Table 8. Percentage Distribution of Children

by Nutritional Indices

Quartile Rank	Nutritional Indices		
	Arm Girth	Weight	Subcutaneous Tissue
	(%)	(%)	(%)
4	65)	43)	6)
	)84	)86	)33
3	19)	43)	27)
2	13)	11)	56)
	)16	)14	)67
1	3)	3)	11)

The distribution of the children by these indices shows that 84% of their arm girth indices and 86% of their weight indices were in the upper half of the distribution but only 33% of their subcutaneous tissue indices fell in the upper half of the distribution. In picturing an average child of this group from these indices he would seem to be of average weight for his height, age, sex and build; his muscular development would be average, but he would lack or have poor subcutaneous tissue. This might seem to indicate that most of the children in this community have been receiving enough calories to approximately keep up to weight but there are lacking certain food essentials in their diet which have caused a lack of development of healthy body tissue. However since no dietary study was made this cannot be a dogmatic statement for there may be other unseen factors which are affecting the nutritional status of these children.

The physician's physical examination showed the following total number of defects in the children:

Temporary teeth	23
Permanent teeth	12
Tonsils	12
Lymph glands	10
Thyroid	8
Vision	8
Ears	4
Other	4

This examination given at the school could not of course be as thorough as one given in a doctor's office or at a clinic. All of the defects observed in the school examination were of the type that undoubtedly have been accumulating over a period of years. There is little doubt that faulty diet may have been an important factor in their development but there may also have been other contributing factors. All during the study a large number of the children had colds and during March there was an epidemic of influenza. On March 15 when the hemoglobin test was to be made, twenty-eight of the forty-eight were out of school, and in April twenty-two children were out with colds and other communicable diseases. During the study there were several cases of measles, chicken pox, mumps and whooping cough. The teacher reported there had always been a high incidence of communicable diseases each year. An inadequate diet and poor living conditions are probably contributing causes.

When home visits were made it was found most of the children lived in very small, crowded, tar-paper covered shacks and some in basement houses. The sleeping conditions were very crowded and the ventilation bad.

In spite of these conditions most of the houses were remarkably clean. A description of one family will serve as an example: In a small tar-paper covered one-room shack live two adults and two girls age nine and twelve. In the one room was a double bed, cot, stove, cupboard, table and portable closet. The house had just been sealed inside with heavy cardboard, instead of plaster, covered with paper from a sample wall paper book; no two pieces were alike. The floor had wide cracks in it, but it was clean. This family was on direct relief and received $13.30 per month for groceries and in addition one quart of milk per day. The family received surplus commodities which vary from month to month, but on an average this family of four received per month: 3 lbs. beans, 6 lbs. butter, 5 lbs. whole grain cereal, 10 lbs. corn meal, 12 lbs. graham flour, 25 lbs. wheat flour, 25 lbs. grapefruit, 3 lbs. prunes or peaches, 3 lbs. raisins and 6 lbs. rice. Since most of the families in this community are either on direct relief or on W.P.A. they would all receive the surplus commodities. Hence the hypothesis used at the beginning of this study that the diet of these children may be lacking in some food essential, might not be true. This also may account for the fact that there was not a greater difference between the nutritional status and hemoglobin levels of the experimental and control groups.

During the physical examination several mothers told the doctor that their children had poor appetites and just didn't care to eat. In talking to the children while weighing them it was found that many of them did not get up in time for breakfast. Those who ate breakfast usually had pancakes, doughnuts or fried eggs; several mentioned oatmeal. Most of the children liked milk and drank all they could get, which often was only one glass per day. Their food dislikes, which were surprisingly few, included eggs, spinach, tomatoes and liver.

The validity of this information on diet is perhaps somewhat questionable since Roberts (43) states there is a tendency for both children and parents to "put the best foot forward". The findings will therefore tend to err on the side of presenting too favorable a picture of the situation rather than the reverse.

When one considers all of the factors which might have exerted an unfavorable influence on a tendency to weight gains, such as season, infection, unfavorable environment and perhaps unsuitability of diet, the general physical condition of all the children was remarkably good. There is some indication that the weights and general health of the children receiving the supplement of vitamin B_1 was more uniform since the percent of those failing to gain was less than half that of the control group.

SUMMARY

A study was made on forty-eight children ranging from five to twelve years of age for a period of three months from February 15 to May 15. The children were divided into two groups. The first group received each school day two cookies to which had been added 200 international units of vitamin B_1 in the form of thiamin chloride. The other group received similar wafers without added thiamin chloride.

A comparison of the nutritional status of the children in the two groups was made by two methods: (1) determination of the average hemoglobin level and (2) a judgment of physical growth as determined by anthropometrical measurements and a physician's examination.

The average hemoglobin level for the forty-eight children studied was found to be 13.41 ± .13 grams with a standard deviation of 1.34. The average of the experimental group was 13.97 ± .19 grams with a standard deviation of 1.40, while the control group had an average of 13.36 ± .17 grams and a standard deviation of 1.28. Eighty percent of these values fell within a range of 11.50--14.50 grams.

In the group which received the vitamin B_1 wafer there was only a 5% increase in the number of children below their expected weights, while in the control group there was an increase of 12%, during the period of study.

In analyzing gains in weight by intermittent three-month periods, there were only half as many in the experimental group as in the control group who failed to gain during the period of observation.

The anthropometrical measurements showed that 84% of the children of this group were in the upper half of the distribution in muscular development; 36% for weight indices but there were only 33% for subcutaneous tissue index.

The physicians examination showed the most frequent defects to be: dental caries, infected tonsils, enlarged lymph glands, slightly enlarged thyroid and defective vision.

The addition of 200 international units of vitamin B_1 to the daily diet showed a slight improvement in the physical growth of the experimental group over a control group which did not receive additional vitamin. Another study carried out at a season of the year in which the children are likely to be more free to gain in weight would seem worthwhile.

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