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THE CANADIAN RED CROSS SCHOOL MEAL STUDY*

BY THE FOLLOWING INVESTIGATORS

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THE purpose of the study was to observe the effects of a well-balanced school meal on the growth, the physical and dental condition, the mental development and school achievement and the absenteeism of the children. Its effects on the eating habits of their families were also investigated. The study had to be carefully planned because of the following considerations:

1. Economic conditions were good in Canada at the time. It was recognized that because of the relatively high level of employment, service men's gratuities, and children's allowances, most of these children would likely be receiving fair meals at home.

2. It was not expected that the effect of one good meal each school day, that is, five meals out of twenty-one each week, over a period of only two years, would be great.

Plan of the study.—The Toronto Department of Health suggested that children attending the three schools known as Park, Dufferin and Sackville in the Moss Park area would probably be the most suitable for the purpose. This part of the city was chosen because its population was relatively stable and was representative of a low income group.

It was decided that a sample consisting of 200 children receiving the school meal and a second group of 200 controls, not receiving the meal, would satisfy the statistical requirements. In order to be sure of having 200 pairs at the end of the study it was estimated that the number at the beginning should approximate 300 pairs. Children from five and a half to ten and a half years of age at the outset were chosen.

To obtain 300 pairs of children, 1,000 of them were given preliminary medical and dental examinations so that none having gross physical defects such as heart disease or albumin in the urine would be included. Their weights and heights were taken and all were given group intelligence tests. The school records of the children were consulted in order to match them at the outset on school achievement. Information concerning the families' socio-economic conditions was obtained by home interviews carried out by City Public Health nurses. We are much indebted to them for this assistance.

In all, data for matching the children were obtained on each of the following points: the school, grade and classroom; the average marks during the previous school year; the chronological age, mental age and intelligence quotient; the condition of the teeth, tonsils, heart and urine; the racial origin and time in

* As this study was of national importance it was financed by the Canadian Red Cross Society. The late Dr. Tisdall was chairman of the National Nutrition Committee of this Society.

Canada of the father and mother; the stability, atmosphere, eating habits, and sleeping arrangements in the home; the recreation and sleeping hours of the child; a total economic status score obtained from the home interview form; the nurse's rating of the home and remarks concerning special conditions.

Pairs of children were matched exactly on sex, medical examination, school grade and classroom, and as closely as possible on age, height, weight, economic status, dental conditions, mental ability and school achievement. One child of each pair was placed in the control group and ate at home as usual, whereas the other received the school lunch. This was done in order to determine whether the gain of the lunch group was greater than the expected gain. The member of each pair to receive the school meal was chosen at random with the following exceptions: (1) Members of one family were placed in the same group. (2) The grouping for 20% of the pairs was decided by their parents who wished their children to be in the control group only. The parents were almost all Canadian born or of Western European origin.

Methods used for following the progress of the children.—(1) Blood samples were taken at regular intervals throughout the study to determine the nutritional status of the children by biochemical means. Frequent chemical analyses of the food as served were made.

2. Five food surveys at 6-monthly intervals were carried out in the homes for two purposes; (*a*) To get information on what was lacking in the children's diets so that the school meals might compensate for these deficiencies. (*b*) To obtain data on the family food habits at the beginning and the end of the study.

3. A complete medical examination was given at the beginning, half way through and at the end of the study. Physical measurements were made more frequently.

4. Measurements of physical fitness were made every 6 months.

5. A careful dental examination was given at the beginning and at the end.

6. The pupils were tested for school achievement and intellectual development every spring during the three years.

7. Records of absenteeism were kept.

The lunch room opened in January, 1947, and closed in April, 1949. The lunches were served in the basement of a church situated within easy walking distance from all three schools.

The analysis of the data was complex because there were several divisions in the study and each division provided a large number of questions to be answered. The statistical side of the planning of the study and all of the statistical analysis of the results were carried out under the direction of H. M. Fowler. Approximately 12,000 Hollerith cards were punched for facilitating the analysis of the data by means of an I.B.M. machine.

BIOCHEMICAL INVESTIGATIONS

Biochemical investigations were included to provide objective evidence of differences in some of the dietary factors between the school lunch and control groups. Due to practical considerations, the biochemical tests were confined to those that could be applied to amounts of blood obtainable from a single finger stab. Bessey and Lowry[1] have developed a variety of micro techniques that enable one to determine a number of components on a very small sample of blood or serum. We used their methods in this study with little or no modification. Determinations were made of hæmoglobin, serum protein, ascorbic acid, vitamin A, carotene, and serum riboflavin.

In addition to these blood studies, periodical collections of duplicate school lunches were made and analyzed for calcium, iron, protein, caloric value, thiamine, riboflavin, niacin, and ascorbic acid. Collections were made of one week's meals once a month. A more detailed account of the analytical methods used will be published elsewhere.

RESULTS

School lunch analyses.—The average results for all the meal analyses are shown in Table I. The standard deviation is also shown. The third column gives the proportion of the recommended daily allowance (1948) of the Food and Nutrition Board, National Research Council, Washington, that was present in the lunches. It can be seen that the lunches made a sizeable contribution to the day's meals and could make up for a considerable dietary deficiency in the home.

Blood analyses: General.—Eight collections of blood were made during the study. The first of these was made in December, 1946, before the school lunch program was begun. Other

TABLE I.

ANALYSES OF SCHOOL LUNCHES

Dietary factor	Mean value	Standard deviation	Fraction of N.R.C. allowance (approx.)
Ascorbic acid mgm.	33.7	± 9.8	1/2
Thiamine mgm.	0.50	± 0.12	1/2
Riboflavin mgm.	0.84	± 0.10	1/2
Niacin mgm.	6.5	± 1.46	1/2
Calcium gm.	0.53	± 0.06	1/2
Iron mgm.	5.60	± 2.1	1/2
Protein gm.	26.2	± 1.7	2/5
Energy cal.	705.0	±56.0	1/3

collections were made in early spring, in the early fall, and in mid-winter.

The biochemical analyses showing significant effects are presented in Figs. 1 to 3. In each case the school lunch group has been subdivided into two divisions. School lunch group A, comprising 87 children, attended 90% or more of the lunches. School lunch group B were those children who attended less than 90% of the lunches. The latter group decreased in size as the program progressed, due to failure to attend the lunches or to removal from the school district. There were 215 children in this group in the beginning and 129 at the fifth collection. Thereafter the number remained quite steady, decreasing only to 113 by the eighth collection. Of these only 12% had attended less than half of the lunches. The control group consisted of 290 children at the beginning. This decreased progressively to 216 children at the end of the study. The statistical methods used to assess the significance of the observations will be published elsewhere.

Serum ascorbic acid.—Fig. 1 shows the mean values observed for serum ascorbic acid. Statistical analyses revealed that the apparent differences shown at the first, third and sixth collection were not statistically significant. This was to be expected as the first collection was made before the lunches were started, while the third and sixth collections were made shortly after the summer vacation during which no lunches were served. On the other hand, the differences at all other collections were highly significant. Hence there is no doubt that the school lunches did raise the serum ascorbic acid level of those pupils who attended them.

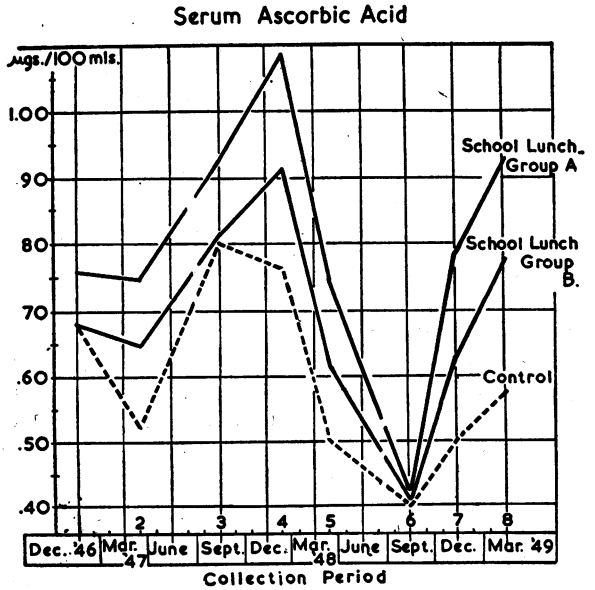

Fig. 1.—The effect of the school lunches on the mean serum ascorbic acid.

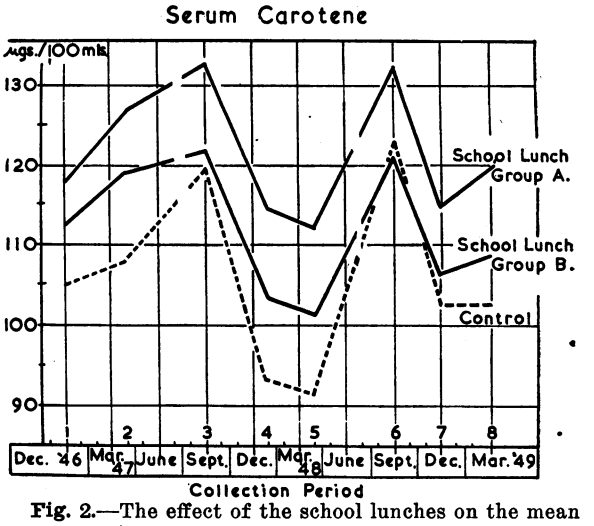

Fig. 2.—The effect of the school lunches on the mean serum carotene.

Serum carotene.—Fig. 2 shows the values observed for the serum carotene at the various collections. The differences between the means at the first, third, and sixth collection were not significant. The difference between the means of each school lunch group and the con-

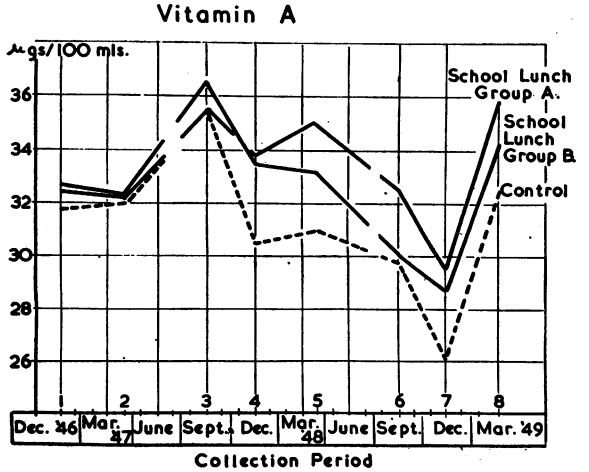

Fig. 3.—The effect of the school lunches on the mean serum vitamin A.

trol was significant at the other collections. Hence the school lunches also raised the level of the serum carotene.

Serum vitamin A.—Fig. 3 gives the graph of the serum vitamin A values. Here the difference of the means is smaller than seen in the ascorbic acid or carotene observations. The significance of the differences between the means for the school lunch Group A and the control and between the means for the school lunch Group B and the control, were tested separately. At collections 1, 2 and 3, there were no significant differences. At collection 4 the differences for both Group A and B were significant. This is interesting because the addition to the lunches of cod liver oil capsules containing 5,000 units of vitamin A had been begun in September, 1947, about the time of the third collection. The difference of the means of Group A and the control remained highly significant on all remaining collections, including collection 6 after the summer vacation. Hence the effect on the serum of the extra vitamin A consumed during the school term lasted over the summer vacation. On the other hand, the level of significance of the difference of the means of Group B and the control dropped at collection 5 and the difference at collections 6, 7 and 8 were not significant. Hence it appears that vitamin A consumed in the amounts that were consumed by Group A have a statistically significant effect on the level of the serum vitamin A. This extra vitamin A consumption was about 20,000 to 25,000 units per week for ten months of the year.

Hæmoglobin.—There was no statistically significant difference between the means of any of the three groups at any collection. There was a progressive significant rise in the hæmoglobin during the course of the study which is attributed to the increase in hæmoglobin normally observed in children of this age group as they grow older.

Serum protein.—There was no significant difference observed between any of the groups either at any single collection or over the duration of the study.

Serum riboflavin.—Here again there was no significant difference in the mean values for any of the three groups at any collection.

DISCUSSION

The biochemical investigations have shown that the school lunches definitely increased the amounts of ascorbic acid, carotene and vitamin A in the blood serum of the school lunch children. The differences observed were highly significant statistically. Whether they were significant nutritionally is another matter. Unless they can be correlated with other beneficial physical, medical, or mental effects this will remain open to question. It is not likely that a child with a serum ascorbic acid level of 1.08 mgm. % (mean of Group A, collection 4) will derive any additional beneficial effect from it compared to one with a level of 0.76 mgm. % (mean of controls, collection 4). Therefore it is unlikely that the "average" child benefited nutritionally from the extra ascorbic acid supplied by the school lunches. However, it is possible that there were individuals who entered on the lunch program in an inadequate nutritional state in respect to ascorbic acid and who derived some benefit from the meals. Taking 0.50 mgm. % as a more or less arbitrary adequate level of ascorbic acid in the serum, special control and experimental groups were made up of children who were below this value at the first collection. The differences at later collections between these special groups were about the same as the differences between the original groups. However, the values assumed some nutritional significance in this case as they made the difference between a low and an adequate level, rather than between an adequate and a superfluous amount. About half the children fell in these special groups.

The differences observed for carotene and vitamin A were so far from being nutritionally significant that they did not warrant the investigation of special low-level groups.

HOME DIETARY SURVEYS

Home dietary surveys lasting one week were carried out on about one-quarter of the families, divided about equally between the school lunch group and the controls. Trained workers went to the home at a time convenient to the mother, and weighed all the food on hand. The mother then listed the amount and cost of all the food she bought in the next seven days, and the worker checked this with her daily. Finally all the food left over at the end of the week was weighed and recorded. The mother recorded the meals eaten by the child or children taking part in the study. Information regarding the number of meals eaten out by the various members of

the family and other pertinent data was obtained.

The first home survey was carried out in November, 1946, three months before the lunch room opened. The surveys were repeated, nearly always on the same families, every May and November during the study. The fifth and last one was carried out in November, 1948. It was found that the food bought by the control families was somewhat superior to that of the school lunch families at the first survey, but the contrary was found at the last survey. On the average the families were buying quite good amounts of milk and milk products, high vitamin C foods and meat, poultry and fish at the beginning of the study. Consequently these families should have been in relatively good nutritional condition. A detailed analysis of the food habits of the individual families is being undertaken at the present time.

A very brief summary of the average differences in the family food spending between the last survey (November, 1948) and the first (November, 1946) is shown in Table II.

TABLE II.
CHANGES IN FAMILY EATING HABITS

Change from November 1946 to November 1948	*School lunch families*	*Control families*
Milk and milk products	8% increase	6% loss
High vitamin C foods (citrus fruits and tomatoes, fresh or canned, and raw cabbage)	8% increase	33% loss
High vitamin A vegetables	11% loss	22% loss
Meat, poultry and fish	6% increase	9% loss
Fruits, except citrus	3% increase	20% loss
Increased expenditure on all foods	$1.09 per person per week	$ .74 per person per week

As for the amount of the other types of foods bought, no differences of any significance between the two groups of families were noted. When the differences found at the time of the last survey as shown in Table II were analyzed statistically (using the individual family records) it was evident that the school lunch families were eating significantly more of the high vitamin C foods and of meat, poultry and fish than the controls. At the last survey the school lunch families were eating about 20 mgm. more of vitamin C per day than the control group. The differences between the buying habits of the two groups in regard to milk and milk products, except butter, and fruit, except citrus, were probably significant statistically. The differences in the use of vitamin A rich vegetables were not significant at all.

In summary, it is evident that the school lunch families were buying more of the best types of food near the end of the school lunch period than they were before it began. In contrast to this, the control families were buying less of these foods. It is also evident that the control families had not increased their expenditures on foods (due to the increased cost of food), as much as the school lunch families. Actually one would have expected the reverse to have occurred as none of their children were receiving free school lunches. Consequently, it appears that the provision of excellent school lunches resulted in an appreciable improvement in the food buying habits of these children's families.

MEDICAL EXAMINATION

All children were examined physically by one of two pædiatricians, both senior physicians on the active staff of the Hospital for Sick Children, Toronto, in November, 1946, November, 1947 and at the end of the study in March, 1949. At no examination did the pædiatrician know to which dietary group the child belonged, nor did he have before him any record of previous findings.

Physical examination consisted of general inspection, with particular attention to any deformities of the chest and long bones indicative of rickets, auscultation of the heart and lungs, estimation of pulse rate and blood pressure and examination of the hair, eyes, lips, tongue and skin for signs which may be indicative of vitamin deficiency. The thyroid gland was palpated, the tonsils were examined for size and inflammation and the anterior and posterior cervical glands were palpated. If any abnormal condition was encountered in the hair, eyes, lips, skin, tongue or skeletal system, the findings were corroborated by the second pædiatrician both as to its presence and degree.

The head was examined for staring hair; in the eyes particular attention was directed towards the presence of conjunctival elevations; lips were observed for swelling, redness, fissuring and angular stomatitis; in the tongue,

papillary atrophy or hypertrophy, fissuring and colour change were noted. The skin was examined for sebaceous changes, xerosis, folliculosis, hyperkeratosis and permanent goose flesh.

In every child, at each examination, these signs were individually charted as to their presence or absence. For those that were detected, the severity was graded as: "+" (slight change) or "++" (moderate to marked).

Points of particular interest to the medical profession in this study are (1) the proportion of primary school children presenting the signs listed above; (2) whether certain of these abnormalities of the hair, eye, lip, tongue and skin, which are considered by some, but a greatly decreasing number of investigators, as pathognomonic of dietary deficiencies, are frequently produced by environmental changes such as wind and weather; and (3) what effect the school lunch had on the health, as indicated by the signs given above, of the school children under observation.

It is manifestly impossible in this article to present the detailed tables of the results. These will be published elsewhere. Only a summary of the findings will be given.

At the initial examination in November, 1946, the percentage incidence of the various medical signs found present at the moderate or marked degree level, which includes all those that would be of clinical significance, was as follows:

TABLE IIA.

PERCENTAGE INCIDENCE OF MODERATE OR MARKED SIGNS

Staring hair—not seen	
Conjunctival elevations—not seen	
Swelling of lips	1.0%
Redness of lips	0.3%
Fissures of lips	1.6%
Angular stomatitis—not seen	
Tongue, papillary atrophy	0.3%
Tongue, papillary hypertrophy	0.5%
Tongue, fissures	0.6%
Abnormal coloration of tongue—not seen	
Skin sebaceous changes—not seen	
Xerosis	0.7%
Hyperkeratosis	0.2%
Permanent goose flesh	0.8%
Folliculosis	1.5%
Enlarged tonsils	13.9%
Inflamed tonsils	2.0%
Enlarged anterior cervical glands	15.5%
Enlarged posterior cervical glands	2.0%
Enlarged thyroid—not seen	
Bony changes indicative of rickets	0.2%

Because of the extremely small number of cases that showed, at any examination, signs rated as being present in a moderate or marked degree (see Table IIA), the analysis of the findings was carried out on the basis of the presence of any of these signs even in the slightest degree.

In some instances the group partaking of the school lunch was subdivided into the good attenders whose record of attendance at the school meal was 90% or more, and the poor attenders.

Tables (not shown here) were drawn up comparing the distribution of the signs in each of the groups at various examinations together with the examination time most favoured, that is, the time, either November, 1946, November, 1947 or March, 1949 when the least percentage of children in each of the groups, that is in the good attenders, poor attenders and control, showed each of these signs. On this analysis it was quite notable that when the school meal group was favoured the control group was also favoured. Therefore it appears to be more easy to explain the results in terms of the conditions that affected all the children, *i.e.*, the kind of weather to which they were exposed at or before the time they were examined rather than in terms of differences between the groups. In other words, there appears to be considerable support for the hypothesis that seasonal differences were much more important than whether the children were or were not partaking of the school meal.

However, what we are interested in is whether the school lunch group was more favoured than the control group. In Table III are grouped all the signs where the differences were at all large, together with a statistical analysis to discover whether the net change favoured the school lunch attenders or the control group.

To clarify this table, the figures given for hyperkeratosis will be explained. It will be noted that the percentage loss for hyperkeratosis in the total school lunch attenders was 8.5% (the difference between the percentage who developed the symptom and the percentage in whom the sign disappeared). The corresponding loss for the control group was 14.7%. In other words, the control group lost more than the school meal group. The difference is 14.7% – 8.5% = 6.2%, which is the net study gain; when the school lunch group was favoured this gain is shown as a positive quantity in the column marked "net study gain" when the control

group was favoured it is shown as a negative quantity. The next column shows the standard error (S.E.) of the net study gain. This is determined by a statistical formula. In general, a gain has to be at least twice as large as its standard error before the result is said to be statistically significant. It is to be noted from Table III that only in the case of fissured tongue does the result approach statistical significance, and even here it does not quite reach that level. From this table one must conclude that the school luncheon did not appreciably improve the children as judged by these examinations.

There remains one other possibility. It sometimes happens that although none of the individual differences are large, a majority of the differences will favour one group or the other. An investigation of this possibility is what might be called a "pattern analysis". Pattern analysis may be quite important in this study because it might be argued that economic conditions being what they were, and the study period being relatively short, and the number of school meals being such a relatively small part of the total number of meals, one could hardly expect any large differences to be forthcoming. However, surely the differences as a whole, small though they might be, should favour the school lunch

TABLE III.

COMPARISON OF THE TOTAL SCHOOL LUNCH GROUP WITH THE CONTROL GROUP WITH RESPECT TO THE INCIDENCE OF VARIOUS MEDICAL SYMPTOMS AT THE BEGINNING AND END OF THE STUDY.

		Condition						
		No change during study		*Change during study*				
Symptom	*Group*	*Absent throughout*	*Present throughout*	*Disappeared*	*Developed*	*Net study gain*	*S.E. of net study gain*	*Significance of gain*
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Hyperkeratosis	School lunch (N=198)	77.3	3.0	5.6	14.1	6.2	4.3	N.S.*
	Control (N=218)	78.4	2.3	2.3	17.0			
Lip swelling	School lunch (N=202)	56.4	8.9	20.3	14.4	-2.9	5.9	N.S.
	Control (N=215)	52.5	10.7	22.8	14.0			
Lip fissure	School lunch (N=198)	18.7	29.8	48.5	3.0	6.4	7.1	N.S.
	Control (N=215)	18.6	29.3	45.6	6.5			
Tongue fissure	School lunch (N=122)	84.5	0.0	13.9	1.6	8.3	4.3	N.S.
	Control (N=127)	89.8	1.6	6.3	2.3			
Enlargement of posterior cervical glands	School lunch (N=200)	22.5	37.5	17.0	23.0	5.9	6.2	N.S.
	Control (N=218)	18.8	39.9	14.7	26.6			
Inflammation of tonsils	School lunch (N=167)	47.9	16.1	16.8	19.2	0.8	6.2	N.S.
	Control (N=189)	48.1	20.1	14.3	17.5			
Rickets	School lunch (N=198)	89.9	0.5	6.1	3.5	1.2	3.0	N.S.
	Control (N=214)	90.2	1.0	5.1	3.7			
Folliculosis	School lunch (N=191)	75.4	4.7	4.7	15.2	-6.2	4.3	N.S.
	Control (N=212)	81.1	1.4	6.6	10.9			

*N.S. = not significant.

group! The results of such investigation are shown in Table IV. In Table III we considered only the eight factors that showed the largest differences, but Table IV summarizes the results for the whole fifteen factors, disregarding the sizes of the differences. It is to be noted then that when the total school meal group is compared with the control group, 9 of the differences favour the school meal group, 3 favour the control group, and in three the differences are zero. By making the appropriate test we were able to determine that this is not a significant pattern. In other words, this could easily arise by chance and therefore we have no reason to believe there is a real difference between the control group and the total school lunch group. However, when we compare just the good attenders with the control group the results are more striking. Here we discover that of the fifteen differences, twelve favour the school lunch group, although some of these are of course very small. This is a definitely significant pattern—at the 1% level. This finding is rather interesting because it suggests that if there had been regular attendance and if the observation had been carried out for a longer period of time more generally significant results might have been obtained.

TABLE IV.

ANALYSIS OF MEDICAL SYMPTOMS

Change from November, 1946 to March, 1949 of Distribution of Symptoms

Group favoured	*Between school lunch and control*	*Between school lunch (90 to 100%) attendance and control*
School lunch	9	12
Control	3	3
Neither	3	—
Total	15	15
Significance of difference	Pattern not significant	Pattern significant at 1% level

APPRAISAL OF GROWTH

Almost invariably the measurements were made by the same assistants, and with the same apparatus. The technique was constant throughout.

Methods of measurement:

1. *Weights.*—At approximately six-monthly intervals, the children were weighed both in their indoor clothing—that is, with their shoes and jackets or sweaters removed—and stripped.

2. *Heights.*—The heights were taken without shoes at the time they were weighed.

3. *Cristal heights.*—The distance between the iliac crest and the soles of the feet with the child standing, was measured on four occasions throughout the study.

4. *Additional measurements for use of McCloy's tables.*—These measurements were taken by the same methods[2] and with apparatus similar to that used by Professor C. H. McCloy of Iowa State University. The technicians carrying out these measurements had been trained by him. This method was used in November, 1947 and February, 1949. The measurements made were as follows: four of the skin and subcutaneous fat, using spring calipers; the elbow, knee and bi-iliac widths; the chest circumference and the maximum girths of the four limbs.

The McCloy Weight Index is determined by dividing the child's actual weight by his "ideal" weight (based on the sex, age and bony measurements, corrected for fat) and multiplying this fraction by 100. At the present time it provides the most accurate method of following a child's growth.

5. *Girths of fore-arms and thighs.* — These measurements were made four times during the study, the first shortly before the lunch room opened and the last a short time before it closed. Care was taken to see that the child's right arm and right leg were in the same relaxed position on each occasion. The circumference of the arm was taken at a point three-quarters of the distance from the distal end of the ulna to the olecranon on the same side. That of the thigh was taken at a point one-third of the distance from the lower edge of the patella to the lower edge of the right external malleolus. Care was taken to see that

TABLE V.

INCREASES IN STRIPPED WEIGHTS AND STANDING HEIGHTS WITHOUT SHOES

Date	*Average stripped weight in pounds*		*Average standing height without shoes, in inches*	
	School lunch children	*Controls*	*School lunch children*	*Controls*
January 1947	57.3	56.8	49.6	49.3
February 1949	73.2	72.0	54.4	54.0
Gain	15.9	15.2	4.8	4.7

a uniform degree of tension was put on the tape when the circumference was measured. The two points chosen gave the maximum circumference for the limbs measured.

Results of Measurements:

The increases in weight and height are shown in Table V.

Therefore, during the 2 years in which the lunchroom was in operation, the school lunch children gained on the average only 7/10 of a pound more in weight and 1/10 of an inch more in height than the controls. These differences were not found to be significant statistically, nor would they appear to be significant practically. The average cristal height measurements showed the same average increase in the two groups of children.

The increase in forearm and calf circumferences are shown in Table VI.

index of 100. In November, 1947, the school lunch and control groups were evenly matched, but at the last examination both of the school lunch groups, and especially the good attenders, had moved considerably nearer the ideal of 100 than the controls.

When the records of the individual children were compared, the figures shown in Table VIII were obtained.

As measured by the McCloy weight index, the pattern of changes from 1947 to 1949 was significantly better (at the 2% level) for the school lunch group than for the control group. The McCloy upper arm indices and fat indices showed no differences between the school lunch and the control children.

In summary, the school lunch resulted in slightly better growth in the children receiving it.

TABLE VI.

AVERAGE MAXIMUM CIRCUMFERENCE OF FOREARM AND CALF

	Average maximum forearm circumference in inches		*Maximum calf circumference in inches*	
Date	*School lunch children*	*Controls*	*School lunch children*	*Controls*
January 1947	7.21	7.25	10.09	10.09
February 1949	7.95	7.92	11.36	11.25
Gain	0.74	0.67	1.27	1.16

TABLE VII.

AVERAGES OF MCCLOY WEIGHT INDICES

		School lunch group					
		Good attendance		*Poor attendance*		*Control group*	
Index	*Date*	*Index*	*No. of cases*	*Index*	*No. of cases*	*Index*	*No. of cases*
Weight (base 100)	November 1947	97.49	87	97.35	163	97.50	262
	February 1949	99.47	87	98.82	115	98.35	220
	Change towards normal	+1.98		+1.47		+0.85	

The differences in favour of the school lunch children appear slight and probably are not of practical importance. However, the statistician reported that the difference between the two groups in the calf measurement gains was statistically significant at the 5% level, which means that it is probably significant, as in only 5 times out of 100 would it occur by chance.

Results obtained by McCloy method.—These results are shown in Table VII. A child whose weight is normal for his height and build should, according to this method, have a weight

PHYSICAL FITNESS TESTS

Method.—Physical fitness was measured by means of a modified form of the step test which was used to assess the fitness of the armed forces during the last war. The test consisted in step-

TABLE VIII.

CHANGES IN MCCLOY WEIGHT INDICES FROM 1947 TO 1949

	School lunch group	*Control group*
Gain shown by	90 children	77 children
Loss shown by	26 children	45 children
No change shown by	86 children	98 children

ping up and down a platform 14 inches high at the regular rate of 30 times per minute. After some preliminary trials it was decided that the duration of exercise should be two minutes for the younger age group (born in 1940 or later) and three minutes for the older children. As soon as the exercise was completed, the children sat down on the platform and were told to relax and be quiet. After 30 seconds' rest, a pulse count was taken for 30 seconds. After another 30 seconds, a second pulse count of 30 seconds was taken and again 30 seconds later, a third pulse count was taken. A fitness index was derived from the values of the pulse and its rate of deceleration. Those finishing the exercise with lower pulse rates and showing faster deceleration are more fit than those with higher pulse rates and slower deceleration.

This index is a measure of the capacity of the cardiovascular system to withstand a certain amount of physical exertion and to recover from it. It increases with training and decreases with lack of training, illness, malnutrition or general poor health.

The test was used in order to see if any difference would be found between the school lunch and the control groups. The investigation was based upon the idea that the better feeding of the group receiving the school meal might produce a higher level of physical fitness.

Results.—These can be summarized as follows:

1. Over the 2-year period of this study, all groups, school lunch and control, boys and girls, showed a gain in physical fitness. This is very likely due to growth and increasing age.

2. The school lunch group and the control group had closely similar scores both at the beginning and the end of the study. The difference in mean gain was not statistically significant, indicating that the school meal program did not improve significantly the physical fitness as measured by this test.

3. Nevertheless, when the boys and girls were considered separately, it was found that the mean gain in fitness score was practically the same for the school lunch and the control groups of boys whereas for the girls, the mean gain was greater for the school lunch group. The difference was not quite large enough to be statistically significant, but it was sizeable and it favoured the school lunch group.

4. When the school lunch and control groups were combined and the physical fitness of the boys was compared with that of the girls, it was found that even in this early age group, the boys were already more fit than the girls. It was also found that the physical fitness of the boys increased more than that of the girls during the two-year period of the study. This result strongly indicates that a better program of physical education would be beneficial for the girls who very probably have lower fitness and show less gain because of lack of regular and adequate physical exercise.

5. On the basis of previous experiments, one can assume that if the children had been in a state of real malnutrition at the beginning of the study, a significant difference between the school lunch group and the control group would have been found at the end. As no significant difference in the physical fitness of the two groups was found, one might conclude that in the absence of real malnutrition, school lunches do not greatly improve physical fitness.

THE DENTAL EXAMINATION

The objective of the dental team was to determine the results of the school meal on the health of the teeth and gums.

Methods.—The observations in this field included a detailed examination of the teeth, supported by bite-wing x-rays to reveal hidden cavities; an examination of the hard and soft structures supporting the teeth; an x-ray examination to disclose supernumerary teeth, missing teeth, and other abnormalities; in addition to colour photographs of the tissues, lactobacillus counts of the saliva and other routine examination procedures. Two comprehensive dental examinations were undertaken for each child, the first shortly before the lunch room was opened, and the second a short time after it closed.

To summarize the results obtained, four factors have been chosen for presentation here. These factors, it was thought, might be sensitive to the benefits of the school meal provided for the children in that group. These include:

1. *Oral hygiene.*—Upon a careful examination of the surfaces of the teeth, the oral hygiene was recorded as Good—Fair—Poor. A change from poor to good was counted as a gain.

2. *Lactobacillus count of the saliva.*—Three specimens of saliva were examined for lactobacillus. The first at the commencement of the study; the second at the end of one year, and the third at the end of the study. A reduction in the count was considered as a gain.

3. *Gingival tissue texture.*—The texture of the gingival tissue was recorded as stippled (normal) and smooth (where the stippling is lost due to slight inflammatory changes). A change from smooth to stippled is counted as a gain.

4. *Bleeding potential of the gingival tissues* was tested with a pressure instrument and recorded as negative if no tendency to bleeding and positive if bleeding was evidenced. A change from positive to negative was recorded as a gain.

For the purpose of evaluating the figures obtained in this study, cases rated "Poor" on the first examination who showed improvement during the study were classified as "Gains" and cases with good rating at the onset who changed to poor rating at the end of the study were classified as "Losses".

Results.—A comparison of the results obtained for the school lunch group and the control group, Tables IX and X, shows so little difference between the relative performance of the two groups, in these four criteria, that the results were not statistically significant. Many other factors for which data were obtained in the study showed similar results which are not presented in Tables IX and X.

The net study difference was obtained as follows: for each group the percentage of "gains" and the percentage of "losses" were obtained; then the percentage of "losses" was subtracted from the percentage of "gains" to obtain the net gain per cent for each group; the difference between these two net percentage gains is what is called the "net study difference".[3]

An examination of the results for dental caries experience suggests that the school lunch group and control group are not essentially different for each of the factors, decayed, filled and missing teeth, but a study of the sum of these three factors favours very slightly the school lunch group, but again the difference is not large enough to reach the point of statistical significance. The results also would not be expected to be of practical significance.

Valuable data have been accumulated in the dental records compiled in this project which will provide material for a series of independent studies, not directly associated with the influence of the school meal, but pertaining to dental problems. For example, during the last six months a study of the eruption of the teeth of children in the age groups included in the study, has resulted in a very significant contribution to the relationship between eruption sequence of teeth and malocclusion.

PSYCHOLOGICAL DEVELOPMENT AND SCHOOL ACHIEVEMENT

The purpose of the work of the psychological

TABLE IX.
TOTAL SCHOOL LUNCH GROUP VS. CONTROL GROUP

Factor	No. of cases		Net study difference	Group favored		Significance of result	
	School lunch	Control		School lunch	Control		
Oral hygiene	188	198	3%		X	Not significant	
Saliva counts							
1st vs. 3rd	133	144	2%	X		"	"
1st vs. 2nd	171	183	2%		X	"	"
2nd vs. 3rd	141	153	3%		X	"	"
Gingival tissue texture	189	205	9%		X	"	"
Objective bleeding	171	181	5%		X	"	"

TABLE X.
SCHOOL LUNCH GROUP WITH GOOD ATTENDANCE (90% OR BETTER) VS. CONTROL GROUP

Factor	No. of cases		Net study difference	Group favoured		Significance of result	
	School lunch	Control		School lunch	Control		
Oral hygiene	81	198	5.4%		X	Not significant	
Saliva counts							
1st vs. 3rd	57	144	0.7%	X		"	"
1st vs. 2nd	77	183	2.3%		X	"	"
2nd vs. 3rd	55	153	7.0%		X	"	"
Gingival tissue texture	80	205	12.7%	X		"	"
Objective bleeding	70	181	9.9%		X	"	"

and achievement division of the school meal study was to assess the effect of the school meal on the mental and scholastic development of the pupils involved. The measures employed were: (1) School marks in the subjects of the curriculum as recorded by the teachers. (2) Scores on intelligence tests. (3) Scores on objective tests in reading and arithmetic.

Data were gathered on these measures in the springs of 1947, 1948, and 1949. The analysis of the data presented some difficulties: (1) Teachers' marks are not highly reliable; (2) Different intelligence and achievement tests had to be used for different classes and at different times in the study. For instance, the intelligence test appropriate for pupils in Grade 5 could not be used in Grade 1, and the arithmetic test administered to Grade 2 pupils in 1947 would not do for the same pupils when they were in Grade 4 in 1949. However, since the school lunch and control groups were matched and treated in identical manners, and since we are interested only in comparative growth, these difficulties should iron themselves out and should not favour one group over the other.

The analysis of the results involved elaborate statistical procedures which need not be gone into here. It is sufficient to record that in none of the measures employed did the growth of one group differ significantly from the growth of the other. In some measures the school lunch group appeared to improve slightly more than the control; in others the reverse was true; but every difference was so small as to be readily attributable to chance. The evidence does not indicate that the school meal program had any effect in accelerating mental or educational development.

When the study was being set up, such a result was anticipated. Evidence on the relation of nutrition to mental processes is too meagre to lead us to expect that two hundred meals a year for two years will effect so uncontrollable a factor as intelligence.

ABSENTEEISM

In this division of the study, data were gathered on each absence which occurred among the school lunch and control children from February, 1947 through March, 1949. These data were analyzed for each group as a whole and also for each pair of children. Between the two groups absence for all causes varied only slightly—the average number of days lost per child in the school lunch group was 18.4 days and it was 19.8 days in the control group. Certain small differences in rates of absence between the two groups were also revealed. For medical causes only, the rate of absence per 1,000 pupil-days was 36.0 for the school lunch children and 39.8 for the control children. For non-medical causes, the rates of absence were 7.9 and 7.5 respectively. Attendance at the feeding centre and these rates were related as follows: among the children who attended the centre for 80% or more of the meals the rate of absence for medical causes dropped from 36.0 to 31.8 and for non-medical causes, from 7.9 to 7.4.

TABLE XI.

EFFECT OF AGE ON ABSENTEEISM

Rates of Absences per 1,000 Pupil-Days				
Initial age	*5½ to 8½ years*		*8½ to 10½ years*	
Group	*School lunch*	*Control*	*School lunch*	*Control*
Cause of absence				
Medical	39.9	39.0	30.7	41.0
Non-medical	8.5	8.4	7.2	6.1

TABLE XII.

EFFECT OF SEX ON ABSENTEEISM

Rate of Absences per 1,000 Pupil-Days				
Sex	*Boys*		*Girls*	
Group	*School lunch*	*Control*	*School lunch*	*Control*
Cause of absence				
Medical	36.3	37.1	35.7	43.0
Non-medical	8.2	7.8	7.6	7.3

Differences in rates of absence were revealed for different age groups and for each sex, see Tables XI and XII.

The significance of the differences in amounts of absence for medical and non-medical causes between the two groups was tested statistically. Such a test requires that the absence for each pair of participants be separated into that experienced by the school lunch partner and that experienced by the control partner. The results of this analysis showed that the two groups were not significantly different in terms of absence for medical or non-medical causes.

CONCLUSIONS

For a little over two years, an excellently planned and prepared school lunch was served to a large group of public school children aged 5½ to 10½ years at the outset. These children were living in a cheap-rent district and their parents were earning low incomes. The price of food was relatively low when the study started. A well matched group of children ate at home and served as controls. The physical condition of the children was good at the beginning and no visible change resulted from the lunches. The gains in height, weight, and in the circumference of the forearm and calf were slightly higher in the school lunch group but the improvement was probably of no practical significance. The girls receiving the school lunch improved slightly more in physical fitness than the control girls. The boys did not. The lunches provided approximately ½ of the recommended daily dietary allowances (N.R.C., Washington, 1948) and resulted in higher levels of ascorbic acid, carotene and vitamin A in the serum of the school lunch children.

Home dietary surveys revealed that the buying habits of the school lunch children's families improved during the course of the study, whereas those of the control families became worse. The school lunch children showed no improvement in the condition of their gums or in their intelligence tests or school progress as compared with the controls. The sum of the decayed, missing and filled teeth in the school lunch children and their absences from school were very slightly less than those of the controls.

In general the effect of the school lunch on the children was very small, but as was mentioned previously, their economic condition was relatively good throughout the whole study.

A great number of individuals took part in this work, including many Red Cross volunteers who helped supervise the lunch room and assisted in the medical and other examinations. The directors of the various divisions are also indebted to the following persons for invaluable expert assistance; Miss W. Leightner, B.H.Sc., Miss P. Scott, Miss W. M. Johnston, R.T., Miss R. Pocock, Miss M. Wilms, B.A., Miss J. M. Wardlaw, M.S., Miss E. W. Porter, B.A., Miss M. Fasken, B.A., Miss F. Service, B.A., Mrs. J. Caven, B.Sc., Miss M. V. Ball, B.A., M. A. Cox, M.B., Margaret Currie, D.D.S., W. J. Dunn, D.D.S., S. A. MacGregor, D.D.S., W. G. McIntosh, D.D.S., Miss D. F. J. Berry, M.A., Miss M. Smale, and Mrs. G. H. Lofts, photographer, and others.

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THE INFLUENCE OF STH, ACTH AND CORTISONE UPON RESISTANCE TO INFECTION*

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AS soon as adequate amounts of cortisone became available for experimental purposes it was noted that heavy overdosage with this glucocorticoid compound decreases resistance to infections. Thus in rats receiving large doses of cortisone, it was found that this hormone "predisposes to the formation of pulmonary abscesses presumably due to a diminution of resistance against the normally non-pathogenic microbes of the bronchial tree".[1] Subsequent observations in rats confirmed these findings and showed, furthermore, that both cortisone and the predominantly gluco-corticotrophic ACTH, when given at highly toxic dose levels, usually cause death as a direct result of unbridled bacterial proliferation. This usually commences in the lung and leads to pulmonary abscess formation, but eventually it may evoke the picture of a general septicæmia with abscesses in the liver, spleen, kidneys and—less frequently—in other organs.

* A brief synopsis of this work was presented before the Lancaster Branch of the American Association for the Advancement of Science, April 4, 1951.