EFFECTIVENESS OF THE SCHOOL LUNCH IN IMPROVING THE NUTRITIONAL STATUS OF SCHOOL CHILDREN

By

O. D. ABBOTT, RUTH O. TOWNSEND, R. B. FRENCH and C. F. AHMANN

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Fig. 1.—Percentage distribution by sex of the children with reference to the degree classification of nutritional diseases. Numerals 0, 1, 2, 3, 4 at the base indicate the degree classification of the conditions observed as defined under methods. See also Fig. 2.
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Since 1930, when results of the first nutritional survey (6) made by the Department of Home Economics of the Florida Agricultural Experiment Station showed the malnourished condition of rural white children in 5 counties in Florida, publications (1, 2, 3, 4, 5) have emphasized the fact that malnutrition is still present and constitutes a major health problem.

During the depression the condition of the under-fed and misfed children throughout the United States was brought to the attention of the Nation. Finding remedial measures became a problem of first order. The school lunch was offered as an alleviating measure. Instituted in a crisis, it now appears to have become a permanent part of the public school system.

The object of this investigation was to study the effectiveness of the school lunch in improving the nutritional status of school children.

SELECTION OF THE SCHOOL

In selecting the location of the cooperating school the following prerequisites were considered advisable: (1) The school should be strictly rural, without a lunch room, and in a section where problems in nutrition were known to exist. (2) The community should offer full cooperation. (3) A large proportion of the patrons should be property owners—insuring a fairly stable school enrollment.

ACKNOWLEDGMENTS.—The authors are indebted to the American Dry Milk Institute for financial support during this 5-year study and to the Florida Citrus Commission for citrus fruits during 1941-42.

1 Registered nurse, formerly Assistant in Home Economics.
2 Practicing physician and consultant for the project.
3 Italics figures in parentheses refer to Literature Cited.
A small school meeting the requirements was located in the north central part of the state, about 14 miles from the county seat and 6 miles from a paved highway. Predominant soil types of the district were Norfolk, Leon and Portsmouth sand and fine sand. About 80 farm families lived in the community; nearly \( \frac{3}{4} \) of them were farm owners or tenants of long standing. The principal crops were tobacco, peanuts, corn and hogs. Staple foods were the chief items bought; each farm produced most of the other foods. Nutritional deficiencies occurred among the cattle and except for isolated spots and a small area along a river, were county-wide. A cursory examination revealed that nutritional deficiencies also occurred among the children.

**PROCEDURE**

The study of the effect of a well-balanced school lunch on health and development of children began in September, 1940, and continued through April, 1945. From the initiation of this study until the close of the school year, April, 1944, the school lunch was planned and prepared under the direct supervision of the Assistant in Home Economics, a registered nurse with special training in dietetics. Changes in the staff at the beginning of the fifth year made it impossible to continue the program as planned. From October, 1944, through April, 1945, the purchase of the food and the supervision and management of the lunch room of necessity were carried on locally. The authors continued to plan the menus, to provide the recipes and to give physical examinations.

**PHYSICAL EXAMINATIONS**

While the primary interest in this study was in the indications of nutritional deficiencies, the examinations given at the beginning and end of the school year consisted of inspections and tests for changes which might have come not only as the result of food deficiencies but also from bacterial infections or from changes where the etiology was not well understood. During the first year an effort was made to alleviate or cure all defects that might inhibit or obscure the effectiveness of the feeding program. Thus, 2 children were fitted with glasses, 8 had tonsillectomies, and 10 were examined by a heart specialist who prescribed treatments. Children with hookworm,

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1 By L. L. Smith, M.D., Valdosta, Georgia.
2 By L. S. Lafitte, M.D., Jacksonville, Florida.
chootic oti"is and such skin defects as ringworm, impetigo and boils were given specific medication at school. In most cases, cures were effected in a few months and thereafter minor ills were treated as they occurred. Children with severe colds and sore throats or those with symptoms of contagious diseases were sent home until the danger of spreading infection had passed.

**STANDARDS AND METHODS**

When possible, uniform standards and methods were used. In any malnourished condition, non-specific and specific indicators are recognized. Non-specific symptoms such as loss of appetite, apathy, slow mental reactions, and drawn and wrinkled skin are, regardless of cause, more or less common in nutritional ill health. Specific and characteristic changes in particular organs and tissues have been accepted as a basis for diagnosis of a deficiency in any 1 food factor. In the following classification the degree of severity of deficiency disease has been given a numerical rating: 0, normal; 1, subnormal; 2, mild; 3, moderate; 4, severe. Further, this degree classification has been associated with progressive changes in a tissue caused by a mounting deficiency. The specific criteria are outlined under blood, eyes, skin, hair, gums and lips.

**Blood.**—The routine examination of the blood consisted of hemoglobin determinations, total erythrocyte counts and microscopic studies of erythrocytes in stained smears. Peripheral blood was used in all determinations.

The concentration of hemoglobin was determined by a Fisher electro-hemometer; total erythrocytes by microscopic examination using a Levy-Hauser counting chamber; and abnormal variation in size and in shape of erythrocytes by microscopic examination of blood smears stained with Wright's stain.

Several more or less arbitrary ranges of hemoglobin have been designated as follows:

0. Normal—hemoglobin values above 13.6 gm. per 100 cubic ml. of blood.
1. Subnormal—11.4 to 13.6 gm. hemoglobin.
2. Mild anemia—9 to 11.4 gm. hemoglobin.
3. Moderate anemia—6.1 to 9 gm. hemoglobin, reduced red cell count (less than 4 million), irregularities in size and shape.
4. Severe anemia—below 6.1 gm. hemoglobin; basophilic degeneration and the appearance of crescent or ghost cells.

**Eyes, Skin and Hair.**—Although a deficiency in vitamin A has
been shown to affect many organs and tissues, changes in the eyes, skin and hair have been accepted as the basis for clinical diagnosis of avitaminosis A.

The degree of conjunctival involvement was designated as follows:

0. Healthy conjunctiva, eyes clear and bright.
1. Any slight departure from normal, either in color or thickness of the conjunctiva or in the dullness of the sclera.
2. Definite injection of the capillaries in the conjunctiva, irritation and redness.
3. Marked injection of the conjunctiva, granulation and local folliculation.
4. Acute injection of the conjunctiva, edema, Bitôt spots and extensive folliculation.

Specific changes in the skin and hair were classed as follows:

0. Healthy skin and hair.
1. Both skin and hair tend to be dry and rough.
2. Dry skin with associated roughness and desquamation especially noticeable on the extensor surface of the arms and legs, across the chest and shoulders. Hair very dry and stiff (staring).
3. Extensive desquamation and xerosis, with papular eruptions about the pilosebaceous and hair follicles.
4. In addition to the above, follicular keratosis and extreme xerosis and atrophy of the skin.

Gums.—While scurvy represents the acute and fully developed case of vitamin C deficiency, frequent and early indications of this deficiency are to be seen in the gums.

The following conditions were noted in assessing the status of the gingival tissues:

0. Healthy gums.
1. Slight congestion in the gingiva.
2. Puffy gingiva, associated with hemorrhagic manifestations and recessions.
3. Gingiva rolled in the interproximal spaces and along the marginal spaces with bleeding and color changes from a bright to a purplish red.
4. In addition to the above, a breakdown of the supporting structures causing a loosening of the teeth, often associated with secondary infections and hematoma.

Lips.—Clinical evidence of a riboflavin deficiency appears to be confined primarily to certain parts of the face and head.
Since the clinical evidence of this deficiency was quite pronounced on the lips, the condition of the lips was classified as follows:

0. Lips healthy.
1. Epithelium red and thinning.
2. Epithelium quite red, shining and wrinkled.
3. Epithelium swollen and scaling, often accompanied by angular stomatitis.
4. Epithelium cracked and bleeding, lesions at the angles of the mouth white and macerated.

Heart Defects.—The heart was examined by means of a stethoscope and the radial pulse. In cases of severe or unusual symptoms the child was taken to a heart specialist for further diagnosis.

Skeletal and Tooth Defects.—Manifestations of abnormal calcium and phosphorus metabolism are shown in the skeletal outline. Skeletal defects were determined by examination of the following:

- Chest: Observations were made as to formation of the chest such as prominent, hollow, pigeon-breasted, and as to beaded ribs and scaphoid sternums.
- Extremities: The extremities were examined for such abnormalities as knock-knee, bow-leg, club-foot and flat feet.
- Spine: The spine was checked for curvature and lordosis.
- Head: Observations were made as to the prominence of the parietal bones.
- Teeth: Examination of the teeth was made by the cooperating dentist of the Bureau of Dental Health, Florida State Board of Health, who noted the general condition of the teeth, such as chalky, unclean, malocclusions, number extracted or needing extraction and number carious.

Bacterial Infections.—In addition to nutritional deficiency diseases, bacterial infections also were present and were factors contributing to ill health. The nose, skin, ears and glands were the parts usually infected. Observations were made for colds and for chronic discharges from nose and throat.

- Skin: The skin was examined for acne, impetigo, boils and other infections.
- Ears: The ears were examined for discharge and otitis.
- Tonsils: The condition of the tonsils was classified as follows:
  0. Healthy tonsils, normal in color, size and shape.
1. Enlarged tonsils.
2. Moderate enlargement with accompanying systemic infection.
3. In addition to the above, enlarged submaxillary glands, and a history of repeated attacks of tonsillitis.
4. Diseased tonsils showing cheesy plugs.

Lymph Glands: The cervical and axillary glands were examined for enlargement. The gland was considered enlarged when it was easily palpable.

Parasites.—Specimens of feces were obtained from nearly all of the children. These were sent to the laboratory of the Florida State Board of Health, where they were examined for intestinal parasites.

Height and Weight Relations.—A measuring stick reading in inches and fractions thereof was used in determining height. This measure was stationary and a square could be moved up and down the scale. In preparation for the determination of height, the child removed his shoes, stood erect with arms hanging naturally at his sides, heels together, with the back of his head against the measure. The square was then brought down firmly to the top of the head and the reading made to the nearest $\frac{1}{8}$ inch.

All weighings were made on the same balance which was examined daily for inaccuracies and adjusted if necessary. The child removed his shoes and outer clothing, stepped on the balance and the weight was read to the nearest $\frac{1}{2}$ pound.

After weight and height measurements were made, the channel of given body type on an age schedule specific for the subject was determined on a grid. The grid devised by N. C. Wetzel, M.D. (8) of the Babies’ and Children’s Hospital and of Western Reserve University, Cleveland, Ohio, consists of a set of calibrated standards. By the use of these standards, growth, development, physique, nutritional grade, age advancement and other items can be separated and depicted graphically from the data on weight, height and age alone.

DIETARY PATTERN

In planning the special feeding program, it was evident from the beginning that a well balanced and adequate lunch should be served. If best results were to be expected, this lunch should be planned according to optimal standards, and furnish at least the minimal daily allowances of essential food factors. Later
When the War Food Administration issued the diet pattern for the 3 types of school lunches it was found that the complete Type A lunch was comparable in all essential food factors to the lunch served in this special feeding program. It was recognized that in cases of severe malnutrition response to a good diet is apt to be slow. Therefore, when hemoglobin values were below 8 grams, supplementary iron was given and when clinical evidence of severe vitamin A or C deficiencies (classed as 4 under methods) was detected, supplements of these vitamins were given. This supplementation was carried out until the child approached the median nutritional level of his group and such supplementation was seldom necessary after the first year. The diet pattern used in this study was as follows:

<table>
<thead>
<tr>
<th>Food Items</th>
<th>Times Served Per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk (1 pint daily—½ pint as beverage)</td>
<td>5</td>
</tr>
<tr>
<td>Eggs</td>
<td>3 to 5</td>
</tr>
<tr>
<td>Meat</td>
<td>3</td>
</tr>
<tr>
<td>Legumes, cheese or fish</td>
<td>2</td>
</tr>
<tr>
<td>Citrus fruit</td>
<td>3</td>
</tr>
<tr>
<td>Other fruit</td>
<td>2</td>
</tr>
<tr>
<td>Dried fruit</td>
<td>3</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>2</td>
</tr>
<tr>
<td>Raw vegetables</td>
<td>3</td>
</tr>
<tr>
<td>Cooked vegetables</td>
<td>5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>5</td>
</tr>
<tr>
<td>Bread (2 to 3 times daily)</td>
<td>3</td>
</tr>
<tr>
<td>Dessert</td>
<td>5</td>
</tr>
<tr>
<td>Butter or fortified margarine</td>
<td>5</td>
</tr>
</tbody>
</table>

It was estimated that with average servings and with the supplementary foods a lunch planned according to the above pattern would furnish the following constituents daily:

- Calories: 1,500
- Protein: 60 to 70 gm.
- Calcium: 0.5 to 0.8 gm.
- Phosphorus: 0.5 to 0.8 gm.
- Iron: 8.5 mg.
- Vitamin A: 4,000 I.U.
- Thiamine: 0.75 to 1 mg.
- Riboflavin: 0.6 to 1 mg.
- Ascorbic acid: 50 to 60 mg.

In preparing the daily menu that would provide these constituents, a wide range of foods was included. During the first 4 years of this study much of the food served came through the government's direct marketing and distribution program, of which the school lunch was a part. Foods coming through this channel were of many kinds, from many sections and processed in various ways. During the last year of the study less food came through government channels and more from local sources. The main food groups and their sources were as follows:
Fruits.—Oranges, grapefruit (both canned and fresh), tangerines, lemons and limes were used. Some of these fruits came from Texas and California but mainly from several sections of Florida. Other fruits used included: Apples from Washington, Oregon and Virginia; pears and persimmons from the school district; bananas from Central America; pineapples from Cuba; and dried fruit from California.

Meat.—Much of the beef, veal and lamb was purchased from neighboring counties, the remainder from local sources. Fresh pork was produced within the county and bacon came through the distribution program.

Milk and Butter.—As there were no dairies in the county, little or no fresh milk was used. The milk requirement was met by the use of dry milk solids and evaporated milk. Milk beverages were prepared by reconstituting these products. In 1940-41 butter was scarce; but during 1941-42 considerable butter came through the distribution program; thereafter small quantities were bought from local sources and through local stores. The larger part of the table fat was furnished by fortified margarine.

Vegetables.—With the exception of canned vegetables, potatoes, cabbage and carrots, which for a time came through government channels, all vegetables were grown within the state. Turnip and mustard greens, collards, sweet potatoes, field peas and other vegetables in season were grown in the school district.

Bread.—Beginning in 1942 all breads were made with enriched white flour or with whole wheat flour; the corn bread for the most part from locally ground meal.

PREPARING AND SERVING THE NOON LUNCH

Contrary to popular belief, malnourished children have very poor appetites and their food consumption is much below recommended standards for children of school age. As a consequence, the first problem of major importance was to get the children to eat. The problem was attacked from several angles.

One of the means used to induce higher food consumption was to increase the nutritive value of all recipes to the limit of acceptable food practices. As supplementary foods, dry milk solids, eggs and butter were the foods used in greatest abundance. In this way a small quantity of food had a high nutritive value.

Another way was to serve appetizers in addition to the regular meal. These consisted of bowls of mixed raw vegetables—
radishes, onions, cabbage, turnips, celery, tomatoes, parsley and any other vegetables that could be served raw. By serving a mixture of vegetables, a child was able to find something he liked. Fresh or dried fruits were given the children as they left the lunch room.

For extremely malnourished children mid-morning and mid-afternoon lunches were served. In the morning the supplement was usually fruit, as this would not dull the appetite for the noon lunch; in the afternoon, something left from the lunch.

As the appetite improved, food consumption increased and foods in wider variety were eaten. Special meals also proved of value in increasing food consumption. On days before holidays the local Parent-Teacher's Association assisted with the preparation of special lunches.

In introducing new foods the Supervisor explained to the children what they were, why they should be eaten and urged each one to eat his portion. Classes in nutrition and food demonstration were held at the school to familiarize parents with the preparation of new foods and new ways of cooking the common ones.

**EXPERIMENTAL RESULTS**

**INITIAL PHYSICAL EXAMINATION**

At the initiation of this study, September, 1940, there were 204 pupils enrolled in the school. Because of parental objection and removal from the district, only 186 children had the prescribed examinations as outlined under methods. The results of these examinations are given in Table 1. The data show the incidence of defects or diseases in all children examined. The prevalent ones were caries, defective tonsils and diseases of nutritional origin: approximately 90 percent of the group had gingivitis, 71 percent anemia, 71 percent conjunctivitis, 64 percent cheilosis and angular stomatitis, and 63 percent skeletal defects. Heart defects which, because of association with anemia, were classed with the deficiency diseases, were found in 22 percent of the children. Nearly 77 percent of the group had some degree of tonsil involvement, 54 percent had chronic colds and 37 percent had otitis and discharging ears. Other defects such as enlarged cervical glands and minor skin infections were found in a smaller but quite significant incidence.

The examination for internal parasites made for the authors by the laboratory of the Florida State Board of Health showed
that about \( \frac{1}{3} \) of the children had some degree of hookworm infestation.

While the differences in the percentages of boys and girls affected with the above defects or diseases were for the most part not very great, in general, the percentages of boys were higher than those of the girls. There were, however, some exceptions. The girls had the higher percentages of heart defects, enlarged cervical glands and skeletal defects. Attention is called to the nearly identical percentages of children with anemia, conjunctivitis, dry, stiff hair, and rough, dry skin.

By plotting height, weight and age on the grid, comparative data on the physical status and developmental age of the children were obtained. These data are summarized in Table 2. According to body build determined by height-weight relations, 53.8 percent of the children were classed as good, 23.2 percent as fair, 12.9 percent as borderline, 4.8 percent as poor, and 5.3 percent as stocky and obese. Variations in percentage distribu-
Effectiveness of the School Lunch

... were slight, and 77 percent of the children were in these classes.

<table>
<thead>
<tr>
<th>Physical status</th>
<th>Both Sexes</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>100</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>Fair</td>
<td>43</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td>Borderline</td>
<td>24</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Poor</td>
<td>9</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Stocky</td>
<td>6</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Obese</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Developmental age</th>
<th>Both Sexes</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Retarded less than 1 year</td>
<td>60</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Retarded from 1 to 2 years</td>
<td>37</td>
<td>16</td>
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<tr>
<td>Retarded more than 2 years</td>
<td>33</td>
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<td>Advanced less than 1 year</td>
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<td>Advanced from 1 to 2 years</td>
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<td>Advanced more than 2 years</td>
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The grid also gives data on the age at which the children of a given height and weight arrive at any developmental level. It is shown that in 6.5 percent of the cases the chronological and developmental ages coincide; in 32.2 percent the developmental age was retarded by less than a year, and in 12.9 percent it was advanced less than a year. It will be noted that nearly 20 percent of the children were retarded from 1 to 2 years, while only about 9 percent were advanced to the same extent. Also 17.7 percent of the group were retarded more than 2 years, while only 2.2 percent were advanced more than 2 years. Percentages of boys with advanced developmental ages were considerably higher than those of girls.

SELECTION OF DATA FOR GENERAL TREATMENT

Ninety-four of the pupils ate regularly in the lunch room for 4 years and 82 were present throughout the entire experimental period of 5 years. Certain data on these pupils were chosen for exhaustive treatment. Results of the examination in 1940 constitute a base line and are used for comparison with those obtained at the end of the school years 1942, 1944 and 1945. That
environmental conditions during the course of the experiment had not improved over the base of 1940 is shown in Table 3, which presents the results of the examination of the children of 6 years of age who entered the school at the beginning of each school year.

In the following presentations, data for 1941 and 1943 proved to be intermediate and were omitted from the graphs.

**TABLE 3.—NUTRITIONAL STATUS OF CHILDREN AT THE AGE OF 6 YEARS ENTERING SCHOOL DURING THE COURSE OF THE EXPERIMENT.**

<table>
<thead>
<tr>
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<td>24</td>
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<tr>
<td>Cheilosis and angular stomatitis</td>
<td>18</td>
<td>72.0</td>
<td>16</td>
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**DISTRIBUTION OF CHILDREN WITH REFERENCE TO DEGREE CLASSIFICATION OF PREVALENT NUTRITIONAL DISEASES**

The percentage distribution of children with reference to the degree classification of the prevalent nutritional diseases or defects is given in Figures 1 and 2 and in Table 4. These data present certain effective results of the special noon lunch.

The changes are presented graphically as distribution curves with intervals representing the degree of clinical deficiency as outlined under methods. Separate curves for girls and boys are presented for level of hemoglobin and condition of the conjunctiva, the gingiva, the lips and the skin.

In all cases the principal effect of the lunch room feeding noted in this presentation is the shift from the norm distribution around a pronounced clinical deficiency to a norm around a condition of sufficiency.

The base norm for 1940 for hemoglobin (Fig. 1 A and B) shows a distribution around a greater degree of deficiency than do the other base norms (Fig. 1 C, D, E, F and Fig. 2 A, B, C, D). In 1945 the hemoglobin curve, unlike the rest, suffered a sharp shift to a distribution around a lower norm.
Effectiveness of the School Lunch

Fig. 2.—Percentage distribution by sex of the children with reference to the degree classification of nutritional diseases and tonsillar defects. Numerals 0, 1, 2, 3, 4 at the base indicate the degree classification of the conditions observed as defined under methods.
TABLE 4.—PERCENTAGE DISTRIBUTION BY SEX OF THE CHILDREN WITH REFERENCE TO THE DEGREE CLASSIFICATION OF NUTRITIONAL DISEASES AND TONSILLAR DEFECTS.

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HEMOGLOBIN VALUES

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FOLLICULAR CONJUNCTIVITIS

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SKIN INFECTIONS

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Provided by the Maternal and Child Health Library, Georgetown University
TABLE 4.—PERCENTAGE DISTRIBUTION BY SEX OF THE CHILDREN WITH REFERENCE TO THE DEGREE CLASSIFICATION OF NUTRITIONAL DISEASES AND TONSILLAR DEFECTS—(Concluded).

<table>
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CHEILOSIS AND ANGULAR STOMATITIS

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DEFECTIVE TONSILS

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Hemoglobin.—The yearly variation in distribution of girls and boys in the several hemoglobin ranges is given in Fig. 1 A and B. At the initial examination (1940) the percentages of both girls and boys having hemoglobin values in the lowest 2 ranges varied slightly and approximately 75 percent of the group had some degree of anemia. In the highest or normal range there were 14 percent of the girls but only 4 percent of the boys.

At the examination made at the close of the school year 1942, 47 percent of both boys and girls had hemoglobin values in the normal range, 24 percent had subnormal values, while the remainder had some degree of anemia. However, there were no children in the lowest range.

The distribution curves for 1944 show the effect of the special school lunch program for 2 additional years, or a total of 4 years. At this time 59 percent of the girls and 52 percent of the boys had normal values, 28 and 24 percent subnormal values, and 13 and 24 percent were still anemic. With the exception of 1 girl there were no children with hemoglobin values in the lowest
2 ranges. It will be noted that thus far the blood picture of the girls is somewhat better than that of the boys.

At the final examination (April, 1945) the percentage of girls in the highest range was identical with that at the beginning of the study; 14 percent now had normal hemoglobin values, 55 percent had subnormal values and 31 percent were anemic. On the other hand, the percentage of boys in the highest range had dropped to only 36 percent, 43 percent had subnormal values and 21 percent were anemic. While the percentages of children in the normal range had decreased there were still no children with hemoglobin values in the lowest range and very few in the next lowest.

**Follicular Conjunctivitis.**—Figure 2 A and B give the percentage distribution of the sexes in regard to nutritional conjunctivitis. The data show that in 1940 while there was little difference in the percentage distribution of girls and boys in the highest or normal range, the percentage of boys having extensive granulation or folliculation was considerably higher than that of girls. In 1942, 52 percent of the girls and 45 percent of the boys had no indications of conjunctivitis; in 1944 the percentages were 57 and 52 percent, respectively. In 1945 there was a slight decrease in the percentage of both boys and girls in the highest range, but no children of either sex had a severe or even a moderate degree of eye involvement.

**Skin Defects.**—Figure 2 C and D show the degree of skin involvement during 1940, 1942, 1944 and 1945. In 1940 the percentages of girls and boys with defects or diseases of the skin associated with a vitamin A deficiency varied slightly. But during 1942 the percentage of girls free from skin defects was considerably higher than that of boys. Sixty-four percent of the girls were in the highest grouping, only 49 percent of the boys. However, at this time there were no children with severe defects of the skin. At the close of the school year in 1945, 61 percent of the girls and 73 percent of the boys were now free from skin defects associated with a deficiency of vitamin A. Six percent of each group continued to show extensive desquamation with papular eruptions, while the condition of the remainder was classed as mild or subnormal.

**Gingivitis.**—Figure 1 C and D show the percentage distribution of the children in regard to the degree of gingivitis. In 1940 the percentages of boys in the lowest 2 ranges were higher than those of the girls in the same ranges. While the girls have
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a higher percentage in the highest or normal range than the boys, only 14 percent of the girls and 8 percent of the boys were in this group. But in 1942, while 2 percent of each group continued to have severe gingivitis with a loosening of the supporting structures, 40 percent of the girls and 45 percent of the boys had healthy gums. The percentage of children in this group continued to increase during the next 2 years and at the end of the school year 1944, 49 percent of the girls and 59 percent of the boys had no symptoms of gingivitis. But in 1945 both groups had suffered some regressions. There were now only 45 percent of the girls and 49 percent of the boys in the highest range. However, there were no subjects in the lowest range and only 2 percent of the girls in the next lowest.

Fig. 3.—Progress of girls along physique channels and in developmental-chronological relations during the course of the experiment.
Cheilosis and Angular Stomatitis.—In 1940, as shown in Figure 1 E and F, 5 percent of the girls and 8 percent of the boys had symptoms of severe cheilosis and angular stomatitis, and 26 and 29 percent, respectively, had no indications of these defects. In 1942 there were no children with a severe form and 45 percent of the girls and 52 percent of the boys were free from these defects. Improvement was considerably more marked by 1944 and 66 percent of the girls and 73 percent of the boys were in the highest range. Both girls and boys suffered some regressions in 1945, 5 percent for the girls and 12 percent for the boys. However, there were no boys in the lowest 2 ranges and only 6 percent of the girls.

Defective Tonsils.—Figure 2 E and F represent the condition of the tonsils according to the degree classification. It will be
noted that the norms for both sexes indicate a mild degree of tonsil involvement. Twenty-one percent of the girls and 7 percent of the boys had tonsils classed as healthy; 14 percent of the girls and 16 percent of the boys fell in the lowest range. The data suggest that there had been no significant change in distribution of either sex in the several ranges throughout the course of the experiment.

GRID RATINGS

Average body build and average developmental age of the children who ate in the lunch room for 4 years are given in Figure 3 for girls and Figure 4 for boys. The basal curve in 1940 is compared with the curves for 1942 and 1944. In 1940 both girls and boys at the age of 6 years were on the line between channels M and A1; but at the age of 7 years and again at 8 years there were shifts towards lower levels, and at 9 years for the boys there was a further shift towards a lower channel. Both the girls and boys at ages 9, 10 and 11 years followed the B1 channel, but at the age of 12 years the girls had made a shift of nearly 2 channels to the right while the boys continued on in the B1 channel. According to the grid, the physical status of the girls was now near the B3 channel. It will be noted that at the age of 13 years the girls had again shifted, this time nearly 3 channels to the left, and were now approaching the A1 line. The shift for the boys which covered only 1 channel came at the age of 14 years, or a year later than that of the girls.

At most ages the curves for the developmental ages in 1940 indicated retardation, as they ran to the right of the 67th norm.

After eating in the lunch room for 2 school years both boys and girls, except for minor deviations, made steady advancement up the M channel of the graph. This progress indicated that growth in height and weight was proceeding according to schedule. When these data were transferred to the developmental chart the curves show that in most cases there was an actual increase in developmental age over the 1940 base.

At the close of the 4th year the curves for both physical status and developmental age varied slightly from those of 1942. The boys continued directly up the M channel while the girls showed a trend toward the A1 channel. The auxodromes for all groups crossed the age lines to the left of, or close to, the 67th norm. This indicated that height and weight in relation to age were following the norm or were slightly advanced.
VARIATION IN AVERAGE HEMOGLOBIN VALUES

In Table 5 data are given on changes in hemoglobin values of girls and boys who ate in the lunch room regularly for 4 to 5 years. These changes are depicted graphically in Figure 5.

### Table 5.—Changes in Hemoglobin Values of Children Who Ate Regularly in the Lunch Room for at Least 4 Years.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Grams Hemoglobin per 100 ml. of Blood</th>
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</tr>
<tr>
<td>F</td>
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</table>

* Iron salts were given from April to September.

It will be noted that there are no consistent variations in hemoglobin values that could be attributed to sex until the groups that started at the ages of 10, 11 and 12 years reached adolescence. In April, 1944, these children were approximately 14, 15 and 16 years old and it is at these ages that the boys have higher values than the girls.

The data show that the rate and degree of hemoglobin response of the children of both sexes and all ages to the improved dietary gave curves of striking similarity. At the beginning of the study in September, 1940, the mean hemoglobin values of all groups were less than 11.1 grams. But at the examination of the children in April, 1941, the values of all groups had increased materially. The largest increases were in the boys of 7 and 12 years and in girls of 7 and 10. However, it was found that during vacation—from April to September—the values for all groups decreased, while from September to April the values...
Fig. 5.—Changes in hemoglobin values of children who ate regularly in the lunch room at least 4 years.

for all groups again increased. For the most part this seasonal variation continued throughout the experimental period. During the second vacation period the hemoglobin values of the boys and girls, starting at 6 years, increased from April to September but iron salts were given this group throughout the summer. During the third summer the boys, starting at 12 years, were able to hold their hemoglobin levels.

The data show that while the hemoglobin levels usually dropped during each vacation, the gains made from September to
April were of such magnitude that a net yearly gain occurred. But during the last year—April, 1944, to April, 1945—the hemoglobin values of all groups fell—the largest losses occurring in boys who started at the age of 7 and 9 years and in the girls who started at the ages of 7 and 8 years.

In addition to those pupils just reported there were 176 children who ate in the lunch room for periods varying from 8 months to 2 years. Hemoglobin values of these children are given by sex and by age in Table 6 and in Figure 6. Here it is shown that the hemoglobin values of these children follow the same pattern as the smaller group, that is, it has a low initial value, increases during the school year, and decreases during vacation.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Sex</th>
<th>Grams Hemoglobin per 100 ml. of Blood</th>
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<tr>
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**DISCUSSION**

From the very nature and extent of the defects found in the first examination, it was evident that many children were suffering from malnutrition due to multiple deficiencies upon which
bacterial infection and parasitic infestation often were superimposed. Signs of nutritional diseases, associated with deficiencies in iron, vitamins A and C, and riboflavin were present.
These were anemia of the hypochromic type, follicular conjunctivitis, skin defects, gingivitis and cheilosis and angular stomatitis.

The severity and degree of involvement of these diseases ranged from a mild to a severe form. Often cases of advanced deficiencies were associated with a secondary infection and tissue destruction. When multiple deficiencies existed and each produced changes in the same tissues it became increasingly difficult to recognize and separate the overlapping symptoms and to diagnose the deficiency. For example, deficiencies in vitamin A and in riboflavin both produce changes in the conjunctiva and skin. When these deficiencies occur together, the final picture may not be characteristic of either; and if secondary infections are also superimposed the diagnosis is still further complicated. Moreover, as yet there are no simple methods for estimating subclinical manifestations of deficiencies of several of the common vitamins. In this study classical signs of deficiencies associated with the lack of thiamine and niacin were present in the adults of the community. The children, however, showed no symptoms specific for deficiencies in these factors. There is, of course, the possibility that many children had a mild deficiency in both thiamine and niacin that could not be detected in the usual examination. In contrast to this, hemoglobin values determined by means of a precision instrument expressed accurately slight changes in hemoglobin levels.

Data from the initial examination furnished the base line for estimating the effective results of the school lunch on the health and development of the children. Each succeeding examination gave a new norm, thereby making it possible to follow not only the yearly trend of the group but also the progress or retardation of the individual. The examination of the children 6 years of age who entered the school during the 4 successive years of the experiment gave evidence that there had been no general improvement in nutritional status over the 1940 base which could be attributed to changes in environment.

The data presented on the children eating regularly in the lunch room for 4 to 5 years indicated that after 2 years there had been a shift towards a higher norm with reference to the degree classification of the prevalent nutritional defects. At the end of the 4th year still more improvement was noted. Not only were there no children in the lowest grouping but also there were
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few in the next lowest, and more than half the group were apparently free from signs of nutritional defects.

In addition to the advance in nutritional status, there were indications that better food had brought about other improvements. These were seen in the shift of grid channels toward better physique and the change in developmental level from a lag to a lead. That the deviations in the up channel progress and the retardation in respect to developmental age of both sexes were associated with a low nutritive status is emphasized by comparing the base line for 1940 with the lines for 1942 and 1944. With an adequate school lunch the progress of both boys and girls was directly up the median channel.

The shift to a lower channel which occurred in the girls of 12 years, or about the age of puberty, is of interest. This is an age of instability and the data indicate that at this physiological age girls are particularly sensitive to food deficiencies and that their requirements are somewhat higher than those of the boys of comparable ages. The sudden cessation of growth in height and the increase in weight for the girls of 13 years suggests a glandular imbalance. The cessation of growth in height and a shift to a higher channel came for the boys at 15 years, or 2 years later than for the girls.

If only the data in the 1940 curve were considered, these deviations in channel might be attributed to sex differences. But during the years when an adequate school lunch was served there were no shifts and progress of both boys and girls was directly up the median channel. It therefore seems logical to conclude that the channel deviations in the 1940 curve were a part of the syndrome of malnutrition.

In previous work with malnourished children (5) it was shown that the fluctuations in hemoglobin found during adolescence had no statistical significance. This was not in conformity with the data reported by Mugrage and Andresen (7), who found that differences in hemoglobin values of boys and girls began in the period between the 13th and 15th years, resulting in higher values for the boys. In Figure 5 it will be noted that after several years of better feeding the hemoglobin values of the boys at the ages of 14, 15 and 16 gradually increased over those of the girls of comparable ages. It now appears that with an improved nutritional status this difference in hemoglobin values which had been reported for adolescents from other sections also occurs in this group.
In the same graph it is shown that the hemoglobin values of both sexes and all ages increased through the school year (September to April, inclusive) and then decreased during vacation. At first glance it might be suggested that the variations were due to changes in seasons, but a more plausible explanation is that the school lunch contributed more of the factors influencing the production of hemoglobin than did the meals prepared at home.

After the second year of improved diet the summer decrease for most of the age groups became less, and each year a small net gain was made. This increased ability to tide over the summer might be attributed to several factors, operating singly or together. With reduction in bacterial infections and in parasitic infestations the general health and resistance would be improved. This would help the child to go through the summer with smaller or no loss of hemoglobin. Or, with better feeding during the past 3 years, the child may have built up a reserve of hemoglobin precursors that would carry him through the vacation period.

For the first 4 years of the experiment hemoglobin values of both sexes and all ages increased throughout the school year and then decreased through vacation. The increase made during the school year was so large that a yearly net gain in hemoglobin occurred. At the end of the 5th year the hemoglobin values of both sexes and at all ages showed a net loss, a fact that is also reflected in the degree classification by a shift from a norm of sufficiency to one of subnormality (Fig. 1 A and B).

These changes and smaller ones in the other degree classifications (Fig. 1 C, D, E, F and Fig. 2 A and B) indicate that during the 5th year the diets were apparently somewhat inadequate in vitamins A, C and riboflavin, but definitely so in factors necessary for regeneration of hemoglobin. In explanation of this dietary inadequacy several factors should be considered. Most important of all, the lunch room during this year was not under the management of a dietitian. Because of transportation difficulties (which were great for this isolated community in 1945) and scarcity of certain foods, many replacements had to be made for important dietary items. These were not always judicious. The resultant of these factors is expressed in the graphed data that suggest that the children were not as well fed during 1945 as they had been in the previous years.

From the data presented it may be concluded that when
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adequately supervised, when planned to take care of known deficiencies, and when special attention and supplementary vitamins and minerals are given as necessary, the school lunch offers an effective means of raising the nutritional status of children.

SUMMARY

A 5-year study has been made of the effectiveness of a school lunch in improving the nutritional status of rural children.

From September, 1940, through April, 1944, the lunch was planned and prepared under the direct supervision of the dietitian. This lunch, planned according to optimal standards, furnished at least the minimal daily allowances of essential food factors. From October, 1944, through April, 1945, the purchase of the food and the supervision and management of the lunch room were carried on locally. The authors continued to plan the menus, furnish the recipes, and to give the physical examinations.

Specific and progressive changes in organs and tissues were accepted as a basis for a degree classification of a deficiency for any one food factor.

Data presented show the incidence of defects or diseases in the 186 children who had the prescribed examinations as outlined under methods. The prevalent defects or diseases were: caries, defective tonsils and diseases of nutritional origin: 90 percent of the group had gingivitis; 71 percent anemia; 71 percent follicular conjunctivitis; 64 percent cheilosis and angular stomatitis; and 63 percent skeletal defects.

Results of the examination in 1940 with reference to the degree classification of the prevalent nutritional defects are compared with those of 1942 and 1944. The principal effect of the school lunch noted in this presentation is the shift in norm distribution around a pronounced clinical deficiency to a norm around a condition of sufficiency.

Data presented show that during the course of the experiment there had been no significant change in the degree classification of tonsillar condition of either girls or boys.

The effect of the school lunch on average body build and average developmental age was shown by comparing the basal curve for 1940 with the curves for 1942 and 1944. With better feeding there was a shift in channels towards better physique and a change in developmental level from a lag to a lead.
For the first 4 years of the experiment hemoglobin values of both sexes and all ages increased during the school year and then decreased during vacation. The increase made through the school year was so large that a net yearly gain in hemoglobin occurred.

During the 5th year the hemoglobin values of both sexes and at all ages showed a net loss. This loss caused a shift from a norm of sufficiency to one of subnormality for hemoglobin, while only slight changes occurred around the other norms. These changes in hemoglobin and the smaller ones in the other degree classifications indicate that during the 5th year the diets were apparently somewhat inadequate in vitamins A and C and riboflavin, but definitely so in factors necessary for regeneration of hemoglobin.

From the data presented it may be concluded that when adequately supervised, when planned to take care of known deficiencies, and when special attention and supplementary vitamins and minerals are given as necessary, the school lunch offers an effective means of raising the nutritional status of school children.

LITERATURE CITED


