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NUTRITIONAL STATUS OF RURAL YOUTH IN MARION COUNTY
(Vitamin C Deficiency)

by

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INTRODUCTION

Relatively few acute dietary deficiency diseases are found in this country. However, it is now recognized that mild or chronic nutritional deficiencies are widespread. A mild deficiency, while it does not keep a person in bed, tends to lower his stamina in every way, his resistance to infections, and his ability to withstand the strains of everyday living, with resulting ill health. In children growth may be decreased, easy fatiguability and lassitude develop, with irritability and inability to concentrate.

That improvement in diet, even over short periods of time, may have decided effects on improving the physical fitness of many persons who are suffering from minor nutritional deficiencies has been demonstrated. General Hershey, in an address before the National Nutrition Conference in Washington, D. C., May 1941, cited the remarkable results which had been attained in England with men rejected for military service for causes which directly or indirectly could be blamed on malnutrition. A large proportion of these men, after a regimen of good diet and hygiene, passed these tests after a few months. This experience was repeated in this country.

A study is now being conducted by the Oregon Agricultural Experiment Station with the cooperation of the General Research Council of the Oregon State Board of Higher Education to evaluate the nutritional status of rural youth in the State of Oregon. The present report covers the work done in Marion County. Later results from other counties will be published. It is hoped that the results will point the way to those changes in the choice of food which must be made in order to raise the general nutritional level of the state and the health and efficiency of our young people.

PROCEDURE AND RESULTS

This report covers the period from May 11 to June 11, 1942 and from October 15, 1942 to April 15, 1943. It includes the results obtained from blood tests and food consumption records of 125 presumably healthy grade school and 53 presumably healthy high school children in Marion County. Approximately 20% of the rural schools were represented, with about 10% of the children in each school chosen for the tests. Only those children from whom two samples of blood were taken on different mornings are included in the results. These samples were tested for hemoglobin content of the blood and for the amount of vitamin C present in the blood plasma.

HEMOGLOBIN

There were 107 grade school children ranging in age from 7 to 15 years (only nine who were over 13 years of age), and 42 high school students ranging in age from 13 to 18 years in the group tested for hemoglobin.

Marion County children in general were not anemic according to present standards. Until the age of 13, boys and girls showed about the same average hemoglobin values, 14.07 grams of hemoglobin per 100 ml. of blood. This is higher than the average value reported by Osgood and Baker who studied 215 healthy children from 4 to 13 years old in Portland, Oregon, and reported an average value of 12 grams of hemoglobin per 100 ml. blood. The range for Marion County grade school children was 11.97 to 16.15.

Table 1. Comparison of hemoglobin values of grade school and high school children of Marion County

	<u>Number of subjects</u>	<u>Average grams of hemoglobin per 100 ml. of blood</u>
Grade school		
7-10 years	15	13.99
11-13 years	83	14.05
14-15 years	<u>9</u>	<u>14.52</u>
Total	107	14.07
High school		
13-14	10	14.95
15-16	19	14.74
17-18	<u>13</u>	<u>14.89</u>
Total	42	14.84

After the age of 13, the boys showed a decided rise in hemoglobin values while the girls showed no such upward trend. The hemoglobin values of high school boys averaged 15.51 grams per 100 ml. of blood, while those of the girls averaged 13.98 grams. This more nearly coincided with Osgood's findings of a mean of 15.8 grams for males over 14 years of age and 13.8 grams for females over 14. (Table 2).

With the exception of one high school girl who showed a level of 10.35 grams, none of the subjects had hemoglobin values below 11.73 grams. One 13-year-old boy had an average hemoglobin value of 18.22 grams, which was the highest recorded in this study, the next value below that being 16.15 grams.

Table 2. Comparison of hemoglobin values of boys and girls.

	Number of subjects	Grams of hemoglobin per 100 ml. of blood	
		Average	Range
Grade school			
Boys	46	14.25	12.35 - 18.22
Girls	61	14.01	11.97 - 15.38
High school			
Boys	24	15.51	12.63 - 17.87
Girls	18	13.98	10.35 - 16.97

These results indicate that apparently most of the children in Marion County are getting sufficient iron in their diet and that iron deficiency does not appear to be a problem in this county.

PLASMA VITAMIN C

The amount of vitamin C in the blood plasma depends on the daily intake of the vitamin. A level of 0.60 mg. of ascorbic acid (vitamin C) per 100 ml. of plasma has been judged adequate by the Committee on Vitamins of the American Academy of Pediatrics (1940), but the level should be considerably higher for optimal nutrition - at least 0.80 mg. per 100 ml. plasma, or more.

Plasma vitamin C values are reported here for 104 grade school and 37 high school subjects. The results show that 62% of the grade school children and 70% of the high school children had plasma vitamin C values below 0.60 mg. per 100 ml. of plasma. The average value for the grade school group was 0.55 mg. The average for the high school group was even lower, being 0.46 mg. per 100 ml.

Table 3. Comparison of blood plasma ascorbic acid (vitamin C) values of grade and high school children.

	Number of subjects	Average mg. of ascorbic acid per 100 ml. plasma
Grade school	104	0.55
High school	37	0.46

Little difference was found between averages for boys and girls in the same age groups for plasma vitamin C (Table 4). There was, however, considerable difference among age groups, with the highest plasma values for the youngest children (Table 5). The averages ranged from 0.76 mg. per 100 ml. of plasma for children less than 10 years of age to 0.35 mg. for those 18 years old or more.

Table 4. Plasma ascorbic acid (vitamin C) levels of boys and girls at different ages.

Sex	10 to 11 years		12 to 13 years		14 to 15 years	
	No. subjects	Average	No. subjects	Average	No. subjects	Average
Boys	15	0.65	23	0.52	15	0.42
Girls	20	0.61	32	0.50	10	0.47

Table 5. Average plasma ascorbic acid values of children of different ages. Expressed as mg. ascorbic acid per 100 ml. plasma.

Age:	<u>Less than 10</u>	<u>10-11</u>	<u>12-13</u>	<u>14-15</u>	<u>16-17</u>	<u>18 and over</u>
	0.76	0.62	0.51	0.44	0.46	0.35

Table 6 compares the plasma vitamin C values of children who were not 4-H Club members with those who were 4-H Club members for one year or less and with those who had been 4-H Club members for more than one year. Although the difference within groups is not great and the small number of subjects does not warrant making any definite conclusions, a consistently lower average vitamin C level was found for all age groups for those subjects who had been 4-H Club members for more than one year.

Table 6. The plasma ascorbic acid values of 4-H Club members and others. Expressed in mg. ascorbic acid per 100 ml. plasma.

	<u>10 to 11 years</u>		<u>12 to 13 years</u>		<u>14 to 15 years</u>	
	<u>No. subjects</u>	<u>Average</u>	<u>No. subjects</u>	<u>Average</u>	<u>No. subjects</u>	<u>Average</u>
Non 4-H Club	13	0.68	22	0.55	10	0.48
1 year 4-H Club	10	0.68	8	0.58	4	0.50
More than 1 year 4-H Club	12	0.53	25	0.45	11	0.38

In table 7, the seasonal variation of average plasma vitamin C levels is shown. Because of the wide range of ages and the small number of cases included in each month's average the table can do little more than show possible trends. The lowest values tend to be in the winter months of December and January. The higher levels in the fall might be expected as a result of the abundance of fresh fruits and vegetables during the summer and early autumn.

Table 7. Seasonal variations in plasma ascorbic acid (vitamin C). Average values expressed in mg. per 100 ml. plasma.

<u>May-June</u>	<u>October</u>	<u>November</u>	<u>December</u>	<u>January</u>	<u>February</u>	<u>March</u>	<u>April</u>
0.45	0.57	0.63	0.46	0.44	0.58	0.51	0.54

FOOD CONSUMPTION RECORDS

Records of food eaten during the week of the test were analyzed to show the relationship between intake of vitamin C-rich foods and the plasma vitamin C level. A total of 165 diet records were examined.

Fruits and vegetables, being the chief source of vitamin C, were divided into three groups and the numbers of servings per week recorded. Group one consisted of citrus fruits and tomatoes, group two of other raw fruits and vegetables, and group three, of all other fruits and vegetables, except dried beans and peas which contain no vitamin C. There was a direct relationship between the number of servings of citrus fruits and tomatoes and also between the number of servings of raw fruits and vegetables and the vitamin C level of the blood plasma (Table 8). Other fruits and vegetables had little influence on the plasma vitamin C level and apparently contributed a relatively small amount of that vitamin.

Table 8. Relationship of numbers of servings of fruits and vegetables and plasma ascorbic acid values in different age groups.

Age group	Mg. of ascorbic acid per 100 ml. Average	Average numbers of servings per week			
		Citrus fruits and tomatoes	Other raw fruits and vegetables	Total citrus fruit, tomatoes and other raw fruits and vegetables	Other fruits and vegetables
Less than 10 yrs.	0.76	5.03	18.55	23.38	16.80
10-11 yrs.	0.62	5.11	7.07	12.18	17.22
12-13 "	0.51	3.92	6.02	9.94	19.25
14-15 "	0.44	4.13	6.09	10.22	17.22
16-17 "	0.46	2.52	4.76	7.28	18.39
18 & over	0.35	3.57	5.32	8.89	17.71

The younger children in general ate more citrus fruits, tomatoes and raw fruits and vegetables than the older children. This fact would partly account for their higher plasma vitamin C levels. But also the vitamin C requirement of adolescents, especially of boys, is considerably greater than that for younger children. Both factors probably contributed to the low values found among the older children.

Further analysis of the diet records was made to determine what varieties of fruits and vegetables were most commonly eaten (Table 9). It is apparent that a limited variety of vegetables are used over and over again: potatoes, lettuce, dried beans, green peas, green beans, corn, carrots and cabbage. The majority of the vegetable soups, stews and mixed salads consisted chiefly of combinations of the above vegetables plus onions and celery. Green leafy vegetables other than lettuce and cabbage were very poorly represented. Such leaves as kale, chard, green broccoli, mustard and turnip greens and Brussels sprouts were eaten by practically no children, yet they are important because they can be easily grown through a large part of the year in Marion County and they are good sources not only of vitamin C, but of calcium, iron, vitamin A and riboflavin.

The consumption of other important foods is shown in Table 10, and the amounts of milk, and of meat, fish and poultry are represented graphically in figures 1 and 2.

A great diversity in milk consumption is apparent, ranging from no milk to 39 glasses per week. This represents milk and cream on cereals and desserts as well as milk drunk as such and in cocoa and other milk drinks, but not that used in cooking. The average for milk consumption was 14.9 glasses per week or about a pint of milk a day, which is considerably below the accepted standard of 1 quart of milk a day for adolescent children. As this was the average consumption, it is apparent that there are a large number of children getting considerably less than a pint of milk. The amount of cheese (Table 10) and milk used in cooking could not possibly have brought the milk consumption of most of them up to accepted standards.

Table 9. Numbers of servings of vegetables and fruits used in 1098 days.

<u>Food</u>	<u>No. of servings</u>	<u>Food</u>	<u>No. of servings</u>
Citrus fruits - total	425	Dry beans and peas - total	242
oranges	325	navy beans	170
grapefruit (1/2)	83	red beans	37
lemons	17	lima beans	16
Tomatoes - total	290	split pea soup	15
tomatoes, raw, stewed, etc.	269	lentils	4
tomato soup	31	Raw fruits - total	652
Potato	1165	apples	532
Raw vegetables - total	429	bananas	40
lettuce	177	grapes	34
cabbage	81	berries	16
carrots	70	peaches	13
celery	60	pears	12
other (mixed salad greens, onions, radishes, etc.)	41	melons	4
Other vegetables - total	888	other	5
vegetable soup	144	Cooked, canned and dried fruit - total	935
green peas	141	peaches	172
corn	132	apples	158
green beans	122	prunes and plums	117
carrots	63	mixed canned	109
mixed vegetable salad	49	berries	99
sauerkraut	35	pears	77
boiled cabbage	33	fruit pies (incl. pumpkin)	52
peas and carrots	26	cherries	47
sweet potato	25	grape juice	19
beets	22	pineapple	18
spinach	20	raisins	18
parsnips	19	cranberries	10
squash	17	apricots	9
onions	14	figs and dates	7
cauliflower	7	rhubarb	6
turnips	4	gooseberries	6
broccoli, green	4	cider	4
rutabagas	4	huckleberries	3
kale	2		
chard	2		
succotash	1		
celery	1		
greens (?)	1		

Table 10. Consumption of milk, eggs, meat, fruits and vegetables.

<u>Food</u>	<u>Average number servings per week</u>
Milk and cream	14.9 glasses
Cheese	1.3 servings
Meat, poultry and fish	7.9
Eggs	3.3
Citrus fruits and tomatoes	4.4
Raw vegetables	2.7
lettuce	1.1 servings
cabbage	0.5
other	1.1
Raw fruits other than citrus	4.2
apples	3.4
others	0.8
Potatoes	7.4
Cooked and canned vegetables	7.1
Dry beans and peas	1.5
Cooked and canned fruits	6.0

The graph for meat, poultry and fish shows that most children ate from 3 to 11 servings per week, with an average of 7.9, or about one serving per day. The recommended standard is one serving or more per day, although with larger consumption of other protein-rich foods as eggs, cheese, milk and dried legumes, the amount of meat, poultry or fish can be safely reduced. A large consumption of these other protein-rich foods was not observed in most cases, however, and a large number of children among those having less than one serving a day of meat, poultry or fish were low also in milk, cheese and eggs. Protein consumption by these children, then, was low. The average number of eggs eaten as such was only 3.3. The protein-rich foods are of great importance to children of all ages, as they provide necessary material for tissue building and growth.

Figure 1. Milk consumption in glasses per week.

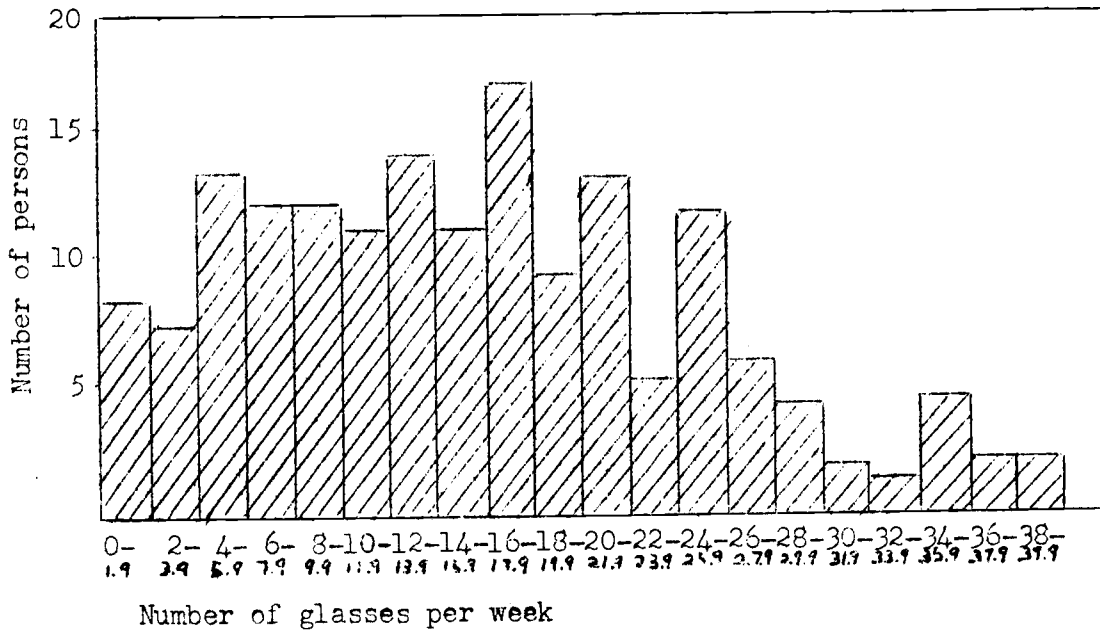
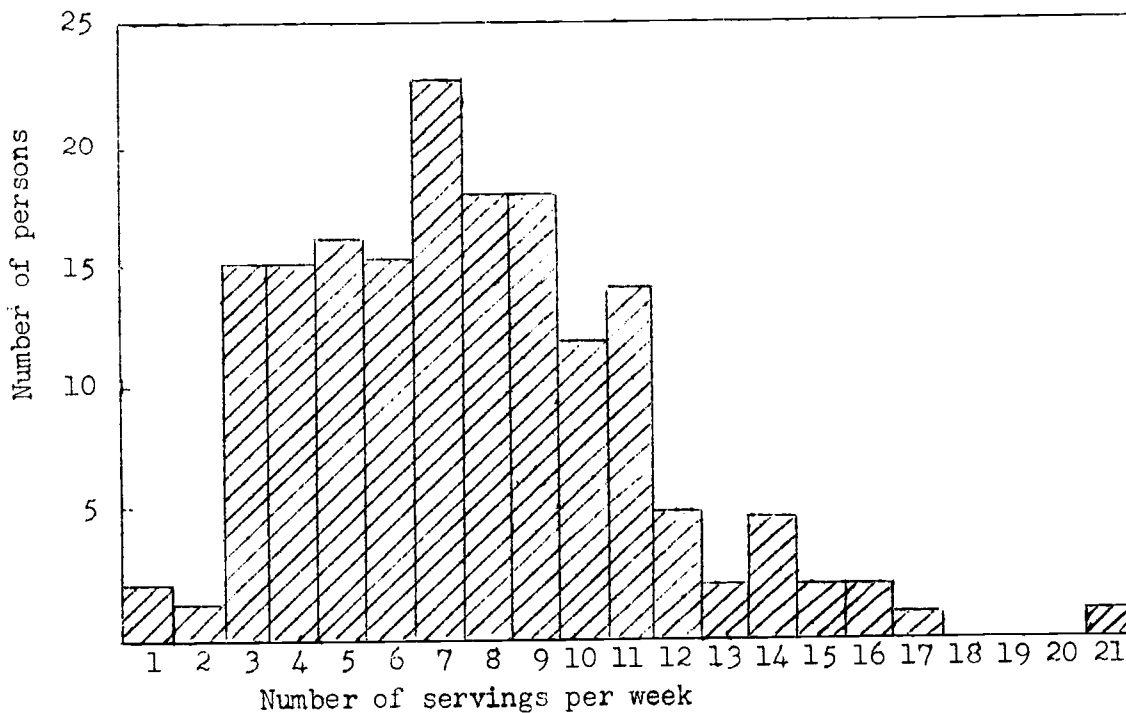


Figure 2. Consumption of meat, fish and poultry in numbers of servings per week.



SUMMARY

1. The hemoglobin values observed in the Marion County school children included in this study were, in general, within the normal range, indicating that iron deficiency apparently is not a problem in this region.
2. Sixty-two percent of the grade school children and 70% of the high school children showed blood plasma vitamin C values below 0.60 mg. per 100 ml. of plasma, which is the lowest level recognized as adequate by the Committee on Vitamins of the American Academy of Pediatrics. A much higher plasma level - at least 0.80 mg. or more - is recommended for optimal nutrition.
3. Average blood plasma vitamin C values decreased with age, ranging from 0.76 mg. per 100 ml. of plasma for children less than 10 years old to 0.35 mg. per 100 ml. for those 18 years and older.
4. A direct relationship was found between the number of servings of citrus fruit, tomatoes and other raw fruits and vegetables eaten and the vitamin C level of the blood plasma. Greater emphasis needs to be placed on the use of these foods, especially by adolescents, not only because of their present low consumption by this group, but also because of the greater need of vitamin C by adolescents.
5. The variety of vegetables used was limited, consisting mainly of potatoes, lettuce, dried beans, green peas, green beans, corn, carrots and cabbage. The more extensive use of other vegetables, especially green leafy ones such as chard, kale, green broccoli, turnip greens and mustard greens would greatly improve the diet in many ways.
6. The average milk consumption amounted to 14.9 glasses per week or approximately a pint a day, which is considerably below the accepted standard of 1 quart of milk a day for adolescent children.
7. Servings of meat, poultry or fish averaged 7.9 servings per week which meets the recommended standard of one or more servings per day. Most children ate from 3 to 11 servings per week. There were a number of children among those eating less than one serving of meat, poultry or fish a day who were also low in other protein-rich foods such as milk, cheese and eggs.
8. In general, more milk, green vegetables, raw fruits and vegetables, citrus fruits and tomatoes, eggs, and meat, fish, poultry or dried legumes should be consumed to meet the standard allowances for an adequate diet.