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Nutritional Status of School Children 15 and 16 Years of Age in Three Idaho Communities

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Table of Contents

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Synopsis

IN THE Western Regional study, "Nutritional status of population groups in selected areas of the West," subjects in nine western states were studied with physical and dental examinations, dietary records and biochemical tests to determine the effect of environment and food habits on physical well-being. In Idaho, the subjects were school children 15 and 16 years of age in the Boise, Nampa and Coeur d'Alene areas. These communities were selected to represent the southwestern and the northern parts of the state.

The dental examinations showed that the teeth of the children in the Coeur d'Alene area were severely affected by decay. The lack of fluorides in the water supplies would only partially explain the severity of the dental problem in the northern part of Idaho.

In general, the physical condition of the Idaho subjects was good and few signs which might be associated with nutritional deficiencies were found. Height, weight and age data were compared with the Baldwin-Wood standards and were plotted on the Wetzel Grid. Skeletal age was estimated from X-ray films. None of the subjects had hemoglobin values indicative of anemia. Sedimentation rates were above average for subjects who were overweight as well as for those with infection.

In addition to the blood and urine tests which are customarily part of a medical examination, 10 biochemical blood factors which might be measures of nutritional status were determined. Few of the values were outside the generally accepted limits of normal. Correlation coefficients were calculated to determine interrelationships among these blood factors. More of these interrelationships were statistically significent in the data of the boys than of the girls.

Records of measured food intake were kept for 7 days by each subject. The average calculated intakes of nutrients were near the levels recommended by the National Research Council, except for the iron intake of the girls. Thirty per cent of the subjects, however, reported diets which supplied less than one-half of the recommended allowances of one or more nutrients (most frequently ascorbic acid, calcium and vitamin A). The nutrient intake of those subjects whose diets did not furnish the recommended amounts of nutrients could be improved by a few changes in food habits.

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Purpose and Plan of Study

The effect of environmental conditions and food intake on physical well-being cannot be determined for human subjects under controlled laboratory conditions. The Western Regional nutritional status study was undertaken on the basis that, in a sense, Nature fixes experimental conditions in a given area, so that a study of subjects in a selected area would give information about the effect of the environmental conditions and established food habits on the physical well-being of persons who had lived a number of years in that area.

The so-called "normal" values for some physical and biochemical measurements are based on a small number of results because few studies have been made on normal groups of subjects. Practically no studies have been made in western areas, so it is not known how well the standards for certain physical and biochemical measurements accepted in other parts of the country really apply to the western population.

In the Western Regional nutritional status study, nutritionists in the Agricultural Experiment Station of each of the nine participating states selected the group of subjects to be studied in that state. In Idaho the group selected was teen-age school children in areas with known differences in the prevalence of dental decay. The results of this study have been considered from two angles: (1) how the Idaho subjects compared with similar groups in other parts of the country; (2) the differences found between the groups of subjects from the two sections of Idaho.

AREAS STUDIED

Idaho has an unusual range of variation in soil, water, latitude and climatic factors which might have an effect on the dental health of children. A study was made of the teeth of freshman students at the University of Idaho in 1950. This study showed that students reared in different areas of the state had widely varying amounts of dental decay (42). Students reared in the southwestern section of the state showed the least incidence of dental decay and those reared in the northern section showed the greatest evidence of decay.

Three communities were selected for study in 1951 on the basis of the area of the state, population, local health facilities and organization and the fluoride content of the municipal water supplies. Two towns were chosen to represent the southwestern section: Boise, with an average fluoride content of 0.5 p.p.m. in the municipal water (typical of the municipal water supplies in much of southern Idaho) and the neighboring town of Nampa, with 1.5 p.p.m. fluorides in its municipal water supply. Coeur d'Alene was chosen to represent the northern section of the state. Subjects from Rathdrum and Post Falls, towns approximately 10 miles from Coeur d'Alene, were included in this group. The municipal water

supplies of these three towns were fluoride-free, as were most of the municipal water supplies in northern Idaho.

The population of Boise was approximately 35,000; the principal occupations of the family wage earners as listed by the subjects were skilled labor, clerical or sales, and professional or managerial. Nampa is 19 miles from Boise in the same irrigated valley. Nampa's population was approximately 16,000; the majority of the wage earners were listed as farmers or railroad employees. Coeur d'Alene, a resort center 300 air-miles north of Boise and Nampa, had a population of approximately 16,000; Rathdrum and Post Falls each had less than 1000 population. The occupations most frequently listed in the northern communities were lumbering and farming, skilled labor and unskilled labor.

Ninety-five per cent of the subjects were of British, German, Scandanavian or French extraction, with only minor variations between areas in the distribution of these nationalities. All subjects were of the white race, although two mentioned that they had an Indian ancestor.

The majority of the subjects in each community expressed a preference for a Protestant church. Seventeen per cent of the Nampa subjects, 10 per cent of the Boise subjects and 4 per cent of the Coeur d'Alene subjects were Roman Catholic. Approximately one-sixth of the subjects in Boise and Nampa were listed as members of the Latter Day Saints (Mormon) church.

SUBJECTS

The subjects, who volunteered to participate in the study, were school children 15 and 16 years of age reared in one of the study communities. A total of 274 subjects completed their records—46 girls and 44 boys in Boise, 54 girls and 40 boys in Nampa, and 50 girls and 40 boys in the Coeur d'Alene area (including 10 girls and 5 boys from Rathdrum and 2 girls and 4 boys from Post Falls). The subjects were students at Boise High School and North Junior High School in Boise, Nampa High School, Coeur d'Alene High School, Rathdrum High School and Post Falls High School.

ORDER OF WORK

The field supervisor or a nutritionist explained the project to prospective subjects in classrooms or assemblies at the schools and distributed slips to be signed by the parents granting permission for the child to participate in the study. When a student returned the signed permission slip, the nutritionist made an appointment with him for an interview at the school during one of his free periods. At the interview the nutritionist obtained background information about the subject, secured a "diet history"—a description of the subject's usual diet and food habits—and told the subject how to keep a record of his measured food intake for 7 days. She gave the subject an instruction sheet with detailed directions for recording the food intake, forms on which to record each day's

food intake and 7 self-addressed stamped envelopes in which to return each record as completed.

When the diet records had been returned, the subject received an appointment for the clinical and dental examinations. A questionnaire to be signed by the parent giving information needed for the medical history was sent with the appointment card. The subject was instructed to come to the clinic without breakfast so that a fasting blood sample could be obtained.

Clinics were held three mornings weekly with six to eight subjects scheduled for examination at each clinic. The Boise and Nampa subjects were examined at the City-County Health Unit in Boise; subjects from Coeur d'Alene, Rathdrum and Post Falls were examined at the Panhandle District Health Unit in Coeur d'Alene. The dental examination was generally scheduled for the same morning, with some subjects going first to the dentist's office and some going first to the clinic.

At a typical clinic, a nurse interviewed the subject to obtain a medical history. Another nurse measured his blood pressure, tested vision and hearing and took X-ray films of his foot and hand for bone density determinations. A medical technician took a 20 ml. blood sample. After the blood sample had been obtained, the subject was offered a lunch of crackers, cheese, apples and milk, because he had come to the clinic without breakfast. The receptionist took the subject's temperature, routed him through the various parts of the clinic examination and had each subject obtain a urine specimen. After the subject had undressed for the physical examination and draped himself with a sheet, he was weighed and measured. The doctor then examined the subject. If the doctor observed any abnormal condition, he sent a report to the subject's parents and family doctor.

At the clinic, the medical technician or the chemist made the urine and blood tests which are usually part of a medical examination. The serum from the remainder of each blood sample was frozen and shipped in dry ice to the Home Economics Research laboratory at Utah State Agricultural College. Three chemists in that laboratory made the biochemical determinations on the serum from all the subjects in the Utah and Idaho phases of the Western Regional nutritional status study.

PERSONNEL FOR FIELD WORK

Physicians

Jack R. Farber
Lynne C. Fredrikson

Dentists

Gordon L. Williamson
Walter Matson
Frank O'Halloran
Jack A. Rice
Robert M. Scates
Forest J. Schini

Nutritionists
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Louise S. Rencher
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Chemists
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Technicians
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Nurses
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Public Health nurses, Panhandle District Health Unit, Coeur d'Alene

Secretaries
Clara E. Moore
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Directors
Ella Woods
Kathleen Porter Warnick,* Field Supervisor

* Agents of the Human Nutrition Research Branch at some time during the study.

Dental Examinations

CLASSIFICATION OF SUBJECTS

In the dental phase of this study, the subjects were those students in the group of volunteers who had been born in and were continuous residents of the communities being studied. Continuous urban residence was not a requirement for participation in this study, but detailed information on places of residence was obtained for each subject, and the dental findings classified accordingly. Students who had not been away from the study community or the adjacent farming district more than two months in any year were considered continuous residents of the area; those who had used the municipal water supply since birth were classed as continuous urban residents. The age and sex distribution of the subjects whose dental findings are reported is given in Table 1.

Table 1.—Age and sex distribution of subjects who were continuous residents of three Idaho communities

Continuous residence	Girls			Boys			Total		
	Number	Average age		Number	Average age		Number	Average age	
		yrs.	mos.		yrs.	mos.		yrs.	mos.
Area									
Boise	40	15	10	34	16	0	74	15	11
Nampa	44	16	2	27	16	4	71	16	2
Coeur d'Alene	43	15	11	27	16	0	70	15	11
Urban									
Boise	20	15	8	23	16	0	43	15	11
Nampa	18	16	2	8	16	2	26	16	2
Coeur d'Alene	21	15	11	9	15	11	30	15	11

METHODS

The dental examinations were done in the offices of the local practicing dentists who cooperated in the study. All subjects from Boise and Nampa were examined by one dentist.[1] The five dentists in Coeur d'Alene[2] each examined an equal number of the Coeur d'Alene subjects. The dentists first charted the filled, extracted and carious teeth which were observed using mouth mirror and explorer; posterior bite-wing X-ray films were taken and the findings subsequently charted. Notations were made on the charts to indi-

[1] Dr. Gordon L. Williamson.
[2] Drs. Walter Matson, Frank O'Halloran, Jack A. Rice, Robert M. Scates, and Forest J. Schini.

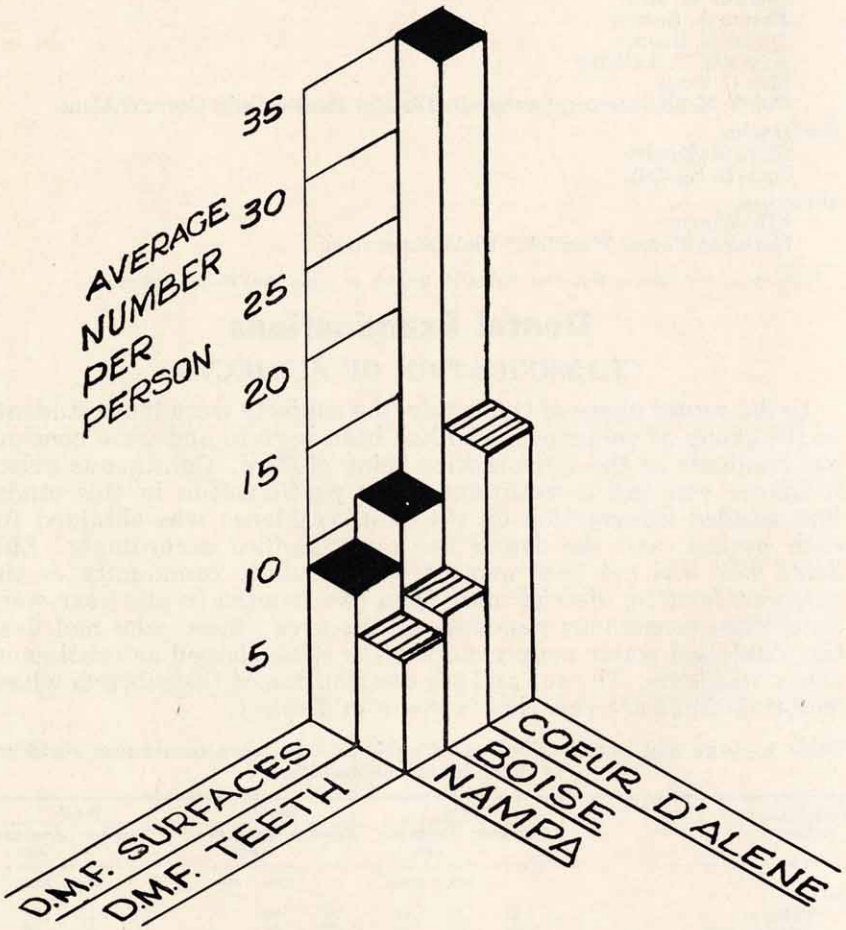

Figure 1. Comparison of the average numbers of D. M. F. (decayed, missing and filled) teeth and tooth surfaces, without X-ray findings, of school children 15 and 16 years of age who were continuous residents in the Nampa, Boise and Coeur d'Alene areas.

cate deciduous teeth and teeth which were unerupted or had been extracted for orthodontic reasons or lost by accident. These teeth were not included in summarizing the results.

Dental caries experience was measured by counting the number of teeth and tooth surfaces (excluding deciduous teeth and third molars) which were carious (decayed), filled or extracted because of caries. The symbol D.M.F. (decayed, missing and filled) was used to designate past and present caries experience.

RESULTS AND DISCUSSION

Dental Caries Experience

The dental caries experience of the boys and girls examined in the three communities is presented in Table 2. The striking difference in average caries prevalence of the Boise and Nampa subjects compared with the Coeur d'Alene subjects is shown in Figure 1. The average number of D.M.F. teeth of the Coeur d'Alene subjects was more than twice as great as for the Boise and Nampa subjects, and the average number of D.M.F. surfaces was three to four times greater. Not only had far more teeth per person been attacked by decay in the Coeur d'Alene area than in the Boise and Nampa areas, but each tooth had been more severely attacked. For the Boise and Nampa subjects the average number of D.M.F. surfaces was approximately one and one-half times greater than the number of D.M.F. teeth, but for the Coeur d'Alene subjects

Table 2.—Dental caries experience of children 15 and 16 years of age in three Idaho communities

Group		Number of subjects	Average number of teeth						Average number of surfaces	
			Filled	Carious by clinical exam.	Carious by X-ray exam.	Extracted	D.M.F.[1]	D.M.F. with X-ray findings	D.M.F.	D.M.F. with X-ray findings
Continuous area residents										
Boise										
	Girls	40	3.88	3.92	2.00	0.50	7.85	8.56	12.05	14.18
	Boys	34	2.65	3.82	3.12	0.29	6.62	8.26	10.32	13.56
	Group	74	3.31	3.88	2.51	0.41	7.28	8.43	11.26	13.82
Nampa										
	Girls	44	4.93	2.30	2.52	0.16	7.00	8.16	10.32	13.23
	Boys	27	2.04	3.37	3.26	0.04	5.30	6.15	6.87	9.96
	Group	71	3.83	2.70	2.80	0.11	6.35	7.68	8.83	11.99
Coeur d'Alene										
	Girls	42	8.81	7.07	5.19	2.83	16.05	17.93	39.28	44.98
	Boys	27	7.04	6.70	5.52	1.63	13.15	15.89	29.63	35.78
	Group	69	8.12	6.93	5.32	2.36	14.91	17.13	35.51	41.38
Continuous urban residents										
Boise										
	Girls	20	2.95	3.85	1.50	0.35	6.55	6.95	9.85	11.40
	Boys	23	2.04	4.09	3.22	0.09	6.13	7.96	8.48	11.91
	Group	43	2.64	3.98	2.42	0.21	6.33	7.49	9.12	11.67
Nampa										
	Girls	18	2.94	1.89	1.50	0.00	4.72	5.56	5.89	7.61
	Boys	8	1.12	3.50	2.50	0.00	4.62	6.00	5.25	8.00
	Group	26	2.38	2.38	1.81	0.00	4.69	5.69	5.69	7.73
Coeur d'Alene										
	Girls	21	10.62	7.05	6.05	2.38	16.90	18.71	39.67	45.81
	Boys	9	10.11	7.11	3.11	1.56	16.11	17.00	37.56	41.00
	Group	30	10.47	7.07	5.17	2.13	16.67	18.20	39.03	44.37

[1] D.M.F. teeth do not equal the sum of the filled, carious, and extracted teeth because some of the teeth were both filled and carious.

there were nearly two and one-half times as many D.M.F. surfaces as D.M.F. teeth. In other words, the cavities or fillings in the teeth of the subjects in the Boise and Nampa areas usually involved only one or two surfaces of a tooth, but in the northern area the cavities or fillings involved two or three surfaces.

Portions of the dental examination charts of two of the subjects in this study are shown in Figure 2. These charts were selected as being typical of those for the subjects in the northern and in the southwestern sections of Idaho. The first subject had the same number of D.M.F. teeth as the average for the subjects in the Coeur d'Alene area; the second subject had the same number as the average for the subjects in the Boise and Nampa areas.

The range in number of D.M.F. teeth including X-ray findings for the continuous urban residents was 0 to 20 for the Boise group,

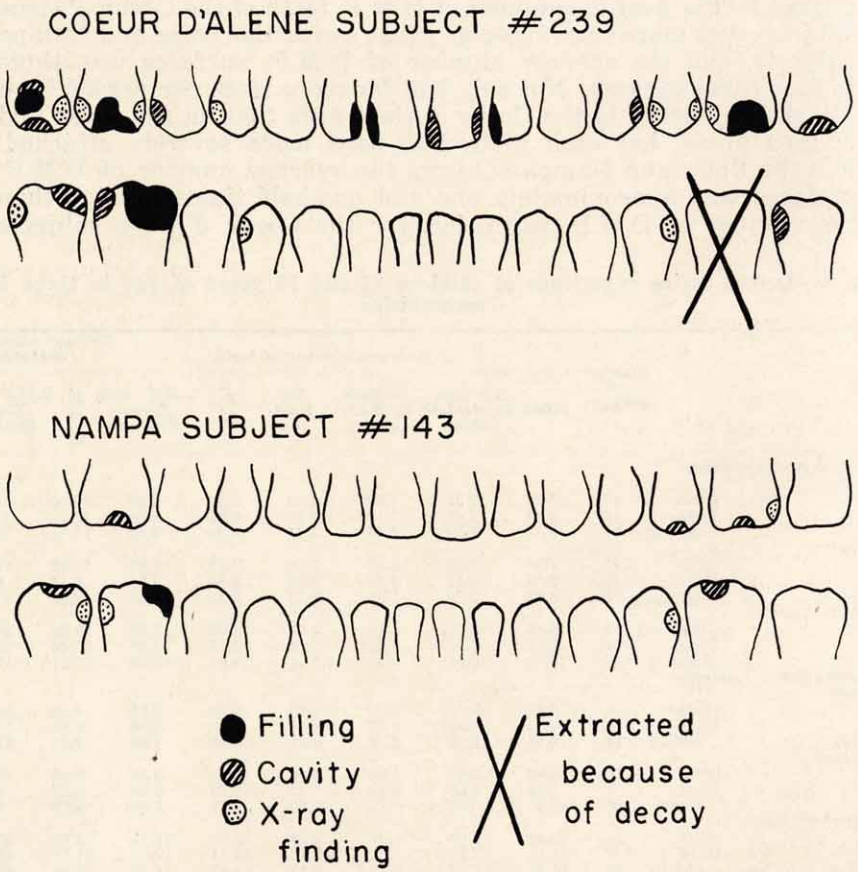

Figure 2. Portions of typical dental examination charts of subjects from the northern and southwestern sections of Idaho.

0 to 17 for the Nampa group and 10 to 28 for the Coeur d'Alene group. Five of the subjects in the Boise area and four in the Nampa area had no D.M.F. teeth; two of the Coeur d'Alene subjects had complete upper dentures. The average caries prevalence of the continuous urban residents of Coeur d'Alene, 16.7 D.M.F. teeth or 18.2 D.M.F. teeth including X-ray findings, was higher than has been reported for any corresponding group of subjects.

Comparison of the caries experience of the Boise and Nampa subjects is of particular interest, inasmuch as the fluoride content of the Nampa water (1.5 p.p.m.) is within the range generally considered to be optimum, whereas that of Boise is considerably lower (0.5 p.p.m.). The average number of D.M.F. teeth for the continuous urban residents in Boise was 6.33, with a standard deviation of 4.56; the corresponding group in Nampa averaged 4.69 $\pm$ 3.55 D.M.F. teeth. The Nampa average was 26 per cent lower than the Boise average. For the D.M.F. count including X-ray findings, the figures were 7.49 $\pm$ 4.61 D.M.F. teeth for the Boise group, and 5.69 $\pm$ 4.26 D.M.F. teeth for the Nampa group, 24 per cent lower. These differences, however, are not statistically significant; that is, the probabilities of these differences occurring by chance were about 1 in 10. In the communities studied, as would be true in any town in this state, it was not possible to get a larger number of subjects who were continuous urban residents. Subjects were therefore included who had lived in the adjacent farming area. These children had used municipal water at least while at school, and many had moved one or more times from farm to town. The average number of D.M.F. teeth for the continuous area residents of Boise was 7.28 and of Nampa 6.35, 13 per cent lower. The corresponding figures for the D.M.F. count including X-ray findings were 8.43 D.M.F. teeth for the Boise group and 7.68 D.M.F. teeth for the Nampa group, 9 per cent lower. These differences are not statistically significant.

The high caries incidence among the Coeur d'Alene subjects as compared with the Boise and Nampa group cannot be explained on the basis of poorer dental care. The Coeur d'Alene area subjects, on the average, brushed their teeth more frequently and had been to a dentist more recently than the Boise and Nampa subjects. Fifty-two per cent of the Coeur d'Alene subjects reported brushing their teeth two or more times per day, compared with 34 per cent of the Boise subjects and 30 per cent of the Nampa subjects. (Brushing the teeth less often than once a day was reported by 17 per cent of the subjects in the southern communities and by 13 per cent of those in Coeur d'Alene.) More than half of the Coeur d'Alene subjects had visited their dentists within 6 months of this study and all had visited a dentist in the preceding 2 years, but 2 years or more had passed since 26 per cent of the Boise subjects and 12 per cent of the Nampa subjects had visited a dentist. An additional 5 per cent of the Boise subjects and 8 per cent of the Nampa subjects had never been to a dentist. Although the Coeur d'Alene subjects needed far more dental work than did the

subjects in Boise and Nampa, the amount of the dental work needed in relation to that which had been done was approximately the same for the Coeur d'Alene and Nampa subjects and was highest for the Boise subjects. The ratio obtained by dividing the number of teeth requiring fillings by the number of filled and extracted teeth was 1.04 for the Boise subjects, 0.68 for the Nampa subjects and 0.66 for the Coeur d'Alene subjects.

In each area, approximately 60 per cent of the subjects had been breast fed for more than 3 months. The average number of D.M.F. teeth for the subjects which had been breast fed more than 3 months was 6 per cent lower in Boise and Nampa and 16 per cent lower in Coeur d'Alene than the average for all the subjects which had been breast fed less than 3 months or not at all.

The difference in the fluoride content of the water used in the three communities undoubtedly explains some of the variation in caries-susceptibility in these groups of subjects. On the basis of the studies by Dean *et al.* (21, 22) of children 12 to 14 years of age in 21 cities with varying amounts of fluorides in their water supplies (assuming that the average number of D.M.F. teeth would increase between the ages of 14 and 16 at a rate similar to that at which it increased between the ages of 12 and 14), 16-year-old children in communities with 1.5, 0.5 or 0.0 p.p.m. fluorides in the water supplies would be expected to have about 4.1, 6.7 or 11.2 D.M.F. teeth, respectively. The average number of D.M.F. teeth for the Nampa urban subjects was 4.7, which was somewhat higher than the expected value of 4.1 D.M.F. teeth; the average for the Boise urban subjects was 6.3 D.M.F. teeth, a little lower than the expected value of 6.7 D.M.F. teeth. On the other hand, the value of 16.7 D.M.F. teeth per subject found for the Coeur d'Alene subjects was much higher than the expected value of 11.2, indicating that some factors in addition to the lack of fluorides in the water may be involved in the severe dental health problem in this portion of the state.

Analyses of the five municipal water supplies used by the subjects in this study are presented in Table 3. The water supplies of

Table 3.—Analyses[1] of the municipal water supplies used by subjects in this study

Town	Source	Iron	Magnesium	Calcium	Total hardness as $CaCO_3$	Fluoride
		p.p.m.	p.p.m.	p.p.m	p.p.m.	p.p.m.
Boise	Several wells	0.2 to 0.6	2.5 to 3.4	13 to 34	43 to 99	0.5[2]
Nampa	Artesian wells	0.0	2.5	12	40	1.5
Coeur d'Alene	Lake	0.3	1.9	6	23	0.0
Rathdrum	Surface	0.5	0.8	4	13	0.0
Post Falls	Shallow wells	0.25	2.1	8	29	0.0

[1] From Division of Laboratories, Idaho Department of Public Health, 1948-1951.
[2] Average of tap samples. Different wells vary from 0.15 to 3.5 p.p.m. of fluorides.

the three towns in the northern area (Coeur d'Alene, Rathdrum and Post Falls) are lower than the Boise and Nampa water supplies in calcium, magnesium and total hardness, as well as fluorides. No data are available on the concentration in these water supplies of other factors which have been shown to have an effect on dental caries in experimental animals. For example, vanadium (29) and copper (34) have been shown to inhibit dental caries in the hamster, and manganese (45) has been shown to decrease the development of caries in the rat. Boise and Nampa are in a semi-arid region where the soil was formed under conditions of low rainfall, little leaching and desert shrub vegetation; the soil is characterized by a high calcium content. The soil in the Coeur d'Alene area was formed under conditions of more rainfall, high leaching and forest vegetation; the soil is low in calcium (2). Further studies are needed to establish the relationship to caries susceptibility of soil constituents and of minerals in the drinking water.

Environmental and climatic factors, such as elevation, latitude and the usual amount of sunshine, may have an effect on the dental health of children. Dunning (23) compiled reports of the incidence of dental diseases in various parts of the United States and found that dental caries was significantly correlated with latitude and with distance from the sea coast. Coeur d'Alene is 4 degrees of latitude north of the other study communities, but all three communities are approximately the same distance from the sea coast. Detailed climatalogical data covering the life span of these subjects are not available, but records of the number of clear, partly cloudy and cloudy days are available for the three communities for the period 1940-1947. These and related data are summarized in Table 4. According to these records, during the

Table 4.—Summary of climatological data[1], elevation and latitude of the three Idaho communities studied

Community		Average number of days			Elevation	Latitude
		Clear	Partly cloudy	Cloudy		
					Ft.	
Boise	53-year record	138	98	129	2710	43°34′N
	1940-1947	119	101	145		
Nampa	1940-1947	170	115	80	2482	43°35′N
Coeur d'Alene	1940-1947	131	95	139	2160	47°21′N

[1]From U.S. Department of Commerce, Weather Bureau, Climatological Data, Idaho Section, Annual Reports, 1935-1951.

period 1940-1947 Boise had the lowest average number of clear days—Boise, 119; Coeur d'Alene, 131; Nampa, 170. Long-term records for Boise give the average number of clear days during a 53-year period as 138. Unfortunately, no objective measurements were made of the amount of sunlight in these areas during the period 1935-1951. The Boise-Nampa area had a 5-month period during which the average maximum temperature exceeded 60°, but the Coeur d'Alene area had only a 4-month period of equally warm weather during which outdoor wraps would not interfere with sunlight irradiation. The average precipitation is approxi-

mately twice as great in Coeur d'Alene as in the Boise-Nampa area—Boise 12, Nampa 10 and Coeur d'Alene 23 inches.

Dental studies similar to the present study have been reported from the neighboring states of Oregon (30, 31) and Utah (54). The average number of D.M.F. teeth without X-ray findings for the 15- and 16-year-old subjects in the seven study areas of the three states rank as follows:

	D.M.F. teeth
Nampa, Idaho	6.4
Boise, Idaho	7.3
Oregon Central Counties (Deschutes and Klamath)	10.6
Ogden, Utah (55)	12.2
Oregon Willamette Valley Counties (Marion and Benton)	13.0
Oregon Coast Counties (Coos and Clatsop)	14.3
Coeur d'Alene, Idaho	14.9

X-Ray Findings

An analysis of the data from the bite-wing X-ray films is of interest from two angles—the importance of using X-ray films in the early recognition of carious lesions, and the importance of including X-ray films in dental surveys. The comparison of carious findings by clinical and X-ray examinations of the continuous area residents of the three communities is summarized as follows:

	Boise	Nampa	Coeur d'Alene
Average number of teeth found carious by clinical examination	3.88	2.70	6.93
Average number of teeth found carious by X-ray examination only	2.51	2.80	5.32
Percentage of total carious teeth found by X-ray examination	39.7	50.9	43.5
Percentage increase in number of D.M.F. teeth by including X-ray findings	15.8	20.9	14.9

In each group of subjects, nearly as many additional carious lesions were found by X-ray examination as had been found in the clinical examination. Of the total number of carious teeth, the percentages found by X-ray examination in the three groups of subjects were similar (40, 51 and 44 per cent in the Boise, Nampa and Coeur d'Alene groups, respectively).

In spite of the fact that nearly one-half of the total number of carious teeth in each group of subjects were observed by X-ray examination only, the importance of including X-ray films in surveys to determine the dental status of groups of persons was not demonstrated in this study. The percentages by which the average numbers of D.M.F. teeth were increased by the inclusion of X-ray findings were very similar for the three groups, ranging from 15 to 21 per cent. The relative differences between groups were practically unchanged whether the three groups were compared on the basis of the number of D.M.F. teeth found by clinical

examination only or the number of D.M.F. teeth with X-ray findings. On the basis of number of D.M.F. teeth found by clinical examination, the average value for the continuous area residents in Boise was 49 per cent and in Nampa 43 per cent of the value for the Coeur d'Alene group. With the inclusion of X-ray findings, the average number of D.M.F. teeth for the Boise area subjects was 49 per cent and for the Nampa subjects 45 per cent of the value for the Coeur d'Alene group. These findings agree with the conclusions of other workers (9, 17) that X-ray films are essential for a complete oral examination or for research on methods of caries control, but that they are not necessary in studies comparing the relative prevalence of caries in different areas.

Physical Examinations

MEDICAL HISTORIES

Information for the medical history of each subject was supplied by the parents. Specific questions were asked about the diseases, operations and injuries which the subject had had and about his feeding during infancy. The percentages of the subjects in each community who had a history of certain diseases, operations and injuries are given in Table 5. In each community, nearly all of the subjects had a history of measles; three-fourths, chicken pox; two-thirds, mumps; and somewhat less than one-half, whooping cough. A higher percentage of the girls than of the boys in each community had a history of whooping cough (50 and 38 per cent, respectively). In addition to these four "childhood diseases," pneumonia was the only disease reported for more than 10 per cent of the subjects. Ear infections, scarlet fever and rheumatic fever were reported for 3 to 5 per cent of the subjects. Twenty-four other diseases were reported by 2 per cent or less of the subjects. The incidence of these diseases was approximately equal for the three communities. A higher percentage of the Coeur d'Alene subjects than of the Boise and Nampa subjects reported having more than four colds per year. Boise had the lowest and Nampa the highest percentage of subjects who had had tonsillectomies, but

Table 5.—Percentage of subjects in three Idaho communities who had a history of certain diseases, operations and injuries

	Boise	Nampa	Coeur d'Alene
Diseases			
Measles	97	100	96
Chicken pox	78	80	75
Mumps	68	63	69
Whooping cough	45	48	43
Pneumonia	9	15	13
Number of colds per year			
0-1	30	27	12
More than 4	11	14	23
Operations			
Tonsillectomy	42	56	49
Appendectomy	17	17	11
Broken bones	17	22	19

the percentage of the subjects from both southwestern communities was the same as for the northern community. There were only small differences by community in the percentages of subjects who had had an appendectomy or had broken one or more bones.

For these subjects, who were born in 1934 to 1936, there were no definite differences by area in respect to feeding during infancy. One-fourth of the subjects were not breast fed, one-sixth were breast fed for less than 5 months, one-fourth for 5 to 9 months and the remaining one-third for 9 months or more. The most common age at which these subjects first received solid food was 6 months. One-fourth started solid food at 6 months, one-half started before that age and one-fourth started after that age. Orange juice had been given to 83 per cent of the subjects and cod liver oil to 75 per cent.

GROWTH AND DEVELOPMENT

Height and Weight

The heights and weights of the boys and girls examined in the three communities are summarized in Table 6. The boys averaged

Table 6.—Heights and weights of boys and girls 15 and 16 years of age examined in three Idaho communities

Subject group	Height		Weight	
	Range	Mean	Range	Mean
	in.	in.	lb.	lb.
Boys				
Boise	61.5 - 77.0	67.52	107 - 180	138.1
Nampa	61.0 - 71.5	67.37	98 - 188	139.1
Coeur d'Alene	61.0 - 73.0	67.71	92 - 188	138.7
Girls				
Boise	59.0 - 70.5	63.61	78 - 179	122.4
Nampa	59.5 - 69.5	64.25	88 - 222	124.4
Coeur d'Alene	59.0 - 68.0	63.62	88 - 176	121.5

nearly 4 inches taller and 16 pounds heavier than the girls. There was practically no difference by community for the ranges or means of heights for the boys or for the girls. The ranges in weight differed somewhat more than the ranges in height, but the mean weights of the subjects of the same sex were similar for the three communities.

Baldwin and Wood (3) give the average height for 16-year-old[3] boys as 67 inches and girls, 64 inches. The corresponding standard weights are 134 pounds for the boys and 120 pounds for the girls. (The Baldwin-Wood tables give weight in ordinary clothing but without shoes, coats or sweater. The Idaho subjects were weighed without shoes and wearing a sheet rather than clothing.) The boys in each of the Idaho communities averaged 0.4 to 0.7 inch taller than the Baldwin-Wood average and 4 to 5 pounds heavier. The average height of the Nampa girls was only slightly above the Baldwin-Wood average and the average heights of the Boise and Coeur d'Alene girls were 0.4 inch shorter than the standard.

[3] The average age of the subjects in the Idaho study was 16.0 years.

The average weights of the girls in each community, however, were from 2 to 4 pounds heavier than the Baldwin-Wood standard.

The weight of each subject was compared with the Baldwin-Wood standard weight for a child of that age, sex and height (3). Sixty per cent of the entire group of subjects were of normal weight (standard weight plus or minus 9 per cent); 16 per cent were underweight (10 per cent or more below standard weight) and 24 per cent were overweight (10 per cent or more above standard weight). The distribution of subjects in respect to devi-

Table 7.—Percentage distribution of subjects with respect to deviation of weight from Baldwin-Wood standards for height and age

Subject group	Underweight			Normal	Overweight		
	20% or more	10 to 19%	5 to 9%	± 4%	5 to 9%	10 to 19%	20% or more
Boys	0	15	15	36	11	15	10
Girls	3	15	17	32	10	14	10
Boise	3	10	16	41	4	12	13
Nampa	2	17	16	26	14	15	9
Coeur d'Alene	0	17	16	33	12	15	7

ations from standard weight is given in Table 7. There were only small differences by sex or by community in the percentage of subjects in each weight deviation class.

Wetzel Grid Ratings

The height, weight and age data for the subjects in this study were plotted on the Wetzel Grid for Evaluating Physical Fitness (50). Although the Grid was designed primarily for checking developmental progress over a period of time, single observations plotted on the Grid will give valuable information about the physique (body type), developmental level, relative age advancement or retardation and caloric needs of the individuals studied (51, 52).

When an individual's weight and height are plotted on the Wetzel Grid, the point falls in one of nine channels for classifying physique. Somewhat over one-half of the Idaho subjects (59 per cent of the boys and 52 per cent of the girls) fell in the three center channels —A_1, M, B_1—which denote medium build. A higher percentage of girls than boys were in the A_2 and A_3 (stocky) and in the A_4 (obese) channels (12, 10 and 12 per cent of the girls and 11, 6 and 9 per cent of the boys, respectively). A higher percentage of boys than girls were in the B_2 and B_3 (slender) channels (12 and 6 per cent of the boys, 10 and 3 per cent of the girls). One girl was in the B_4 channel. The physical status of individuals in the B_3 and B_4 channels is considered by Wetzel to be borderline or poor (51).

The physique channels on the Grid are crossed by parallel lines denoting the Isodevelopmental level. This level plotted against the age of the child gives the age schedule of development (auxodrome). The auxodromes indicate the developmental levels which would be reached by 2, 15, 67, 82, and 98 per cent of the general population of healthy children by a given age. The percentages of the Idaho

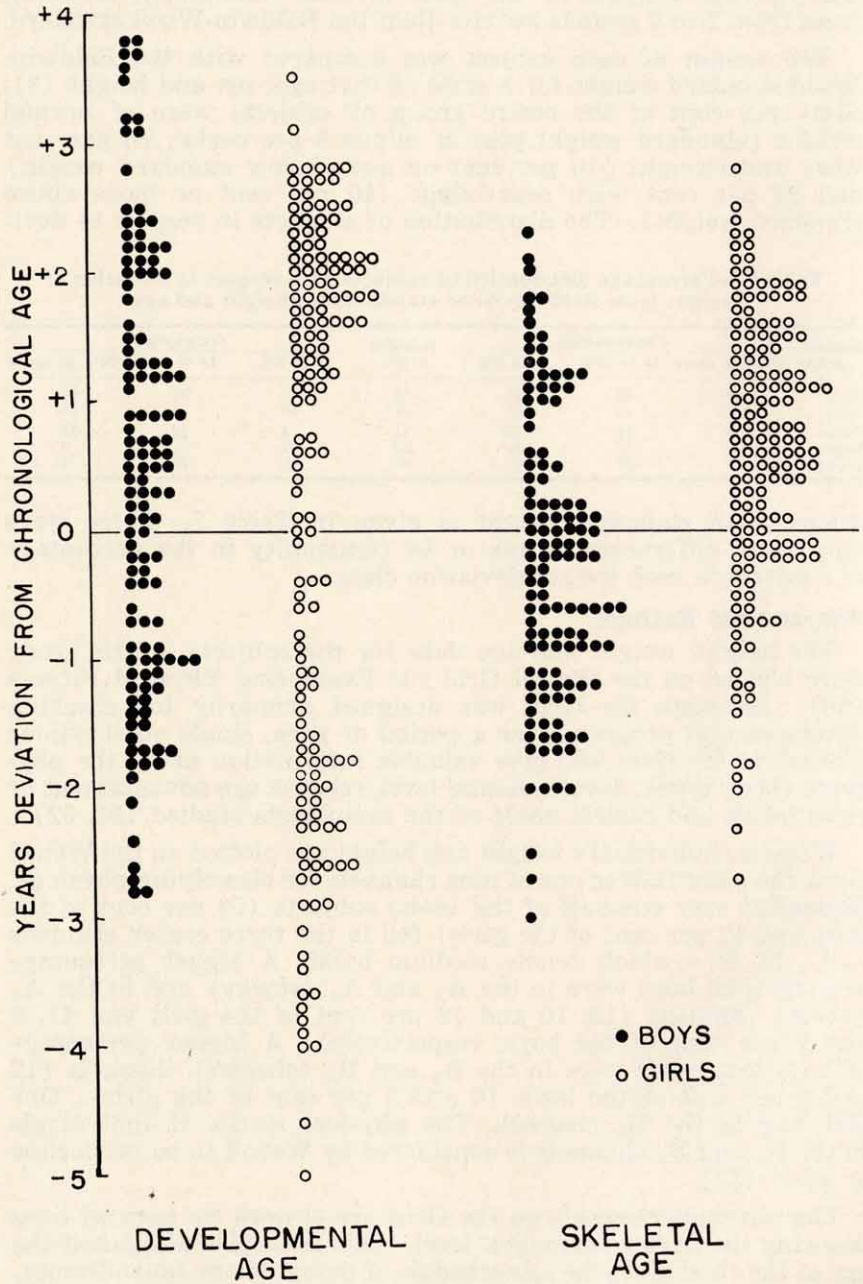

Figure 3. Distribution of the deviations of the developmental age (Wetzel Grid) and the skeletal age (Todd method) from the chronological age.

boys and girls on or ahead of these time tables of developmental advancement were somewhat different from the Wetzel standards. The level which would be reached by 82 per cent of the general population of children the same age had been reached by 92 per cent of the Idaho boys and 97 per cent of the girls. However, only 62 per cent of the boys and 59 per cent of the girls had reached the 67 per cent auxodrome. Twenty-seven per cent of the Idaho boys and 15 per cent of the girls had advanced to or beyond the 15 per cent auxodrome.

The 67 per cent auxodrome—that is, the developmental level reached by 67 per cent of the general population of healthy children by a given age—is the standard by which relative advancement or retardation is measured. The developmental age of a subject is determined from the Wetzel Grid by reading the age at which the 67 per cent auxodrome curve crosses the developmental level of the subject. The advancement or retardation is the difference between the ages at which the subject and the 67 per cent auxodrome curve reach the same developmental level. The distribution of the deviations of the developmental ages from the chronological ages of the subjects in this study is shown in the first section of Figure 3. Forty-three per cent of the boys but only 15 per cent of the girls had a developmental age within a year of the chronological age. The peak in the distribution of the deviations of the developmental ages from the chronological ages for the girls was at around two years advancement, with a lesser peak at around two years retardation.

Skeletal Age

Another estimate of advancement or retardation of growth is skeletal age as determined by a study of X-ray films. The X-ray films of the hand, which were taken in this study for determination of bone density by the Mack technique, were read by Dr. J. R. Farber to determine the skeletal age of these subjects according to the methods initiated by Todd (27). The distribution of the deviation of the skeletal ages from the chronological ages of the subjects in this study is shown in the second section of Figure 3. The peak in the distribution of the deviations of the skeletal ages from the chronological ages shows that for most of the girls the skeletal ages were greater than the chronological ages, but for most of the boys the skeletal ages were less than the chronological ages.

Table 8.—Mean chronological age, developmental age (Wetzel Grid) and skeletel age of boys and girls studied in three Idaho communities[1]

Age	Boise		Nampa		Coeur d'Alene	
	Boys	Girls	Boys	Girls	Boys	Girls
Chronological	16.0	15.9	16.4	16.3	16.0	15.9
Developmental (Wetzel Grid)	16.5	16.0	16.6	16.3	16.6	16.2
Skeletal	15.9	16.7	15.9	16.8	16.0	16.3

[1] Age to tenth of a year.

The mean chronological age, developmental age as determined by the Wetzel Grid and skeletal age of the boys and girls in each community are given in Table 8. The mean developmental age according to the Wetzel Grid was greater than the mean chronological age for the boys in each community, averaging 0.4 of a year greater for all the boys. The mean skeletal age of the boys was 0.2 of a year less than the mean chronological age. The mean developmental age and the mean skeletal age of the girls were both greater than the mean chronological age, with the developmental ages averaging 0.2 of a year greater and the skeletal ages 0.6 of a year greater than the chronological ages.

Comparisons were made of the deviations of the developmental age as obtained from the Wetzel Grid, and of the skeletal age from the chronological age of each subject. The girls were divided into two groups on the basis of age at the beginning of menstruation —12 or younger (66 girls), and over 12 (85 girls). The percentage of the subjects in each group whose skeletal age and developmental age were greater or less than the chronological age are summarized as follows:

Relation to Chronological age:	Girls		Boys
	Age at menarche		
	12 or less	Over 12	
Skeletal age and developmental age both greater	61%	40%	31%
Skeletal age greater, developmental age less	32	18	11
Developmental age greater, skeletal age less	6	12	27
Skeletal age and developmental age both less	1	31	31

Two-thirds of the girls who had reached puberty early had a developmental age greater than the chronological age; 93 per cent had a skeletal age greater than the chronological age. Of the girls who had reached puberty later, 52 per cent had a developmental age greater than the chronological age and 58 per cent had a skeletal age greater than the chronological age. The skeletal age was greater than the chronological age for less than half (42 per cent) of the boys; 58 per cent had a developmental age greater than the chronological age.

Because there was only one height and weight measurement for each subject rather than a series of measurements over a period of time, the development of the subjects could be compared only with the "average"—the 67 per cent auxodrome—on the Wetzel Grid. A series of measurements would have shown into which auxodrome a subject fitted, and his data could have been compared with other subjects in the same age schedule of development. Thus a subject who was naturally small and one naturally large would not have been compared with the same standard as was necessary in this study. In all probability, closer agreement would then have been found between skeletal age and developmental age.

MEDICAL EXAMINATIONS

Medical Observations

The abnormalities observed in the medical examinations of the boys and girls in the three communities are summarized in Table 9. It was impossible in this study to have all the examinations made by one physician, and thus to have avoided the possibility that apparent differences by area in the frequency of certain observations may have been due to differences in training, interest and experience of the examiners. The subjects in Boise and Nampa were examined by J. R. Farber, M.D., and those in the Coeur d'Alene area by Lynne C. Fredrikson, M.D.

The most commonly observed condition was acne, which was noted for approximately 60 per cent of the entire group of subjects. Other skin conditions observed frequently were nasolabial seborrhea (oily plugs in the skin around the nose), follicular plugs or folliculosis (rough, dry, goosepimply skin), hyperkeratosis (overgrowth of the horny layer of the skin) and xerosis (dry, scaly skin). Although most of these skin conditions have been associated with a deficiency of one or more nutrients, it is doubtful if the mild conditions observed in most of these cases were nutritional in origin, and the difference in frequency by community is probably due principally to the difference in examiners. A difference

Table 9.—Summary of certain abnormalities observed by the medical examiner in the physical examinations of boys and girls in three Idaho communities

Medical observations	Number of subjects with stated clinical conditions					
	Boise[1]		Nampa[1]		Coeur d'Alene[2]	
	Boys	Girls	Boys	Girls	Boys	Girls
Eyes						
Blepharitis	0	1	0	2	0	1
Inflammation of conjunctiva	1	1	1	0	0	0
Circumcorneal injection	0	1	0	0	0	0
Ears						
Inflamed	4	0	3	1	0	3
Wax	4	2	0	3	4	4
Drums, scarred, retracted, dull, thickened	6	4	5	9	0	0
	14	13	3	3	0	0
Skin, Face						
Nasolabial seborrhea	9	17	2	5	39	38
Follicular plugs	0	10	1	0	27	14
Acne	26	29	21	26	29	36
Lips and gums						
Angular stomatitis	0	0	0	0	3	5
Gingivitis	0	0	0	0	2	1
Nose and throat						
Nasal discharge	22	10	13	13	10	5
Mucous membrane swollen	3	1	4	6	5	1
Pharyngitis	11	1	7	0	2	3
Tonsillitis	1	1	0	0	13	10
Laryngitis	0	0	1	0	0	1
Enlarged thyroid	0	2	0	1	0	3
Enlarged lymph nodes	0	1	0	0	18	28
Skin, general						
Xerosis	0	1	0	2	5	16
Folliculosis	0	0	0	0	9	9
Crackled skin	1	1	0	0	0	0
Dermatitis	3	2	1	5	0	3
Hyperkeratosis	2	7	0	1	23	28
Other						
Brittle nails	4	2	0	0	1	10
Tenderness in abdomen	0	2	0	3	3	8
Number of subjects examined	45	49	39	53	42	52

[1] Subjects examined by Dr. J. R. Farber
[2] Subjects examined by Dr. Lynne Fredrikson

in the frequency with which two medical examiners noted the presence of folliculosis was also found in a study of college students in New York (57). In that study one examiner reported folliculosis in over one-half of the subjects he examined; the second examiner found it in only 16 per cent.

Conditions associated with the common "cold"—nasal discharge, pharyngitis, etc.—were observed frequently, with the Boise subjects having the highest incidence. Tonsillitis was observed for one-third and enlarged lymph nodes for one-half of the Coeur d'Alene subjects, whereas tonsillitis was observed in only two subjects and enlarged lymph nodes in only one subject in the southwestern communities.

The physician who examined the Boise and Nampa subjects had had special training in the recognition of abnormalities of the heart and skeleton. He observed that 6 boys and 5 girls in the Boise group and 8 boys and 6 girls in the Nampa group had heart murmurs. Five of these were described as functional, but all were referred to the family physicians for further investigation. One leg was observed to be shorter than the other for 1 boy and 5 girls in the Boise group and for 3 boys and 10 girls in the Nampa group. The doctor recommended that these subjects have further orthopedic examination and treatment or special shoes to prevent curvature of the spine, tipped pelvis or similar conditions.

In general, the subjects examined in this study were in good physical condition, and few signs which could definitely be associated with poor nutrition were observed.

Blood Pressure

The measurements of blood pressure, as determined with the sphygmomanometer over the brachial artery, are summarized for the boys and girls in each area in Table 10. According to Best and Taylor (8), the systolic pressure averages 105 mm. Hg at about the twelfth year and rises with the onset of puberty, reaching in boys 120 mm. about the age of 17. In girls the systolic pressure increases to the fifteenth year, then declines to the eighteenth year and remains fairly steady from then on, from 4 to 5 mm. lower than for males. The mean systolic pressures of the subjects in this study—approximately 118 for the boys and 115 for the girls—are about the expected values for 15- and 16-year-old children. The mean diastolic pressures (approximately 72 for the boys and 73 for the girls) are slightly below the expected value of 75 mm. Elevation above the average normal for a particular age of 15 mm. in the systolic and of 8 mm. in the diastolic may be considered to be abnormal (8). The number of subjects with systolic pressures above 130 or diastolic pressures above 80 are given in Table 10. Additional blood pressure determinations would have to be made on these subjects when they were not affected by the excitement and emotional reactions associated with the clinical examination to determine the importance of these elevations in blood pressure.

Radial Pulse

The average frequency of the pulse in men in 65 to 70 per minute, in women, 70 to 80, but a person in perfect health may have a much higher or a much lower rate (36). The average pulse rate for the boys in this study, 72.3 per minute, was somewhat higher than this standard, but the rates for many of the subjects were probably higher than usual because of the excitement due to the clinical examination. The average rate for the girls, 78.5 per minute, was in the expected range. None of the rates were sufficiently high or low to be considered definitely abnormal (Table 10).

Temperatures

The majority of the subjects had a temperature by mouth somewhat below the normal 98.6° F. This would be expected of temperature taken in the morning. Eighteen subjects had temperatures above normal (Table 10), but only two of these were above 99° F. Both of these subjects had colds.

Vision and Hearing

In the clinics for the Boise and Nampa subjects, vision was tested using standard letter charts and diagrams for determining astigmatism. This test was omitted in the Coeur d'Alene clinics because there was not sufficient adequately lighted space available. In the Boise-Nampa clinics, hearing was tested only by a voice test. In Coeur d'Alene an audiometer was available, through the courtesy of the local P.T.A. The results of the vision and hearing tests are included in Table 10.

Table 10.—Summary of certain physical measurements which were part of the physical examination of boys and girls in three Idaho communities

Test	Boise		Nampa		Coeur d'Alene	
	Boys	Girls	Boys	Girls	Boys	Girls
Blood pressure						
Systolic						
Range, mm. Hg	104-144	90-138	98-148	92-150	104-136	100-140
Mean, mm. Hg	119.1	116.6	119.3	114.0	115.9	114.6
Number above 130 mm. Hg	4	3	4	4	1	3
Diastolic						
Range, mm. Hg	54-92	56-94	56-80	56-100	60-80	50-80
Mean, mm. Hg	73.7	73.1	70.8	72.2	72.7	73.7
Number above 80 mm. Hg	3	2	0	2	0	4
Radial pulse						
Range, beats per minute	52-102	60-106	52-100	58-100	52-88	54-104
Mean, beats per minute	74.8	79.9	71.7	77.9	70.5	77.8
Temperature						
Number above 98.6°F.	7	3	5	2	0	1
Vision (one or both eyes)						
Number						
Far sighted—less than 20/15	0	0	2	0	*	*
Near sighted—more than 20/30	10	8	7	11	*	*
Astigmatic	9	6	3	13	*	*
Hearing loss						
Number by						
Voice test	7	6	6	3	*	*
Audiometer test (speech range)	*	*	*	*	13	2

* Not tested for this group of subjects.

with no evidence of renal damage (8). Severe muscular exertion may result in albuminuria. (When it was learned that the subject whose urine gave the most strongly positive reaction for albumin had spent all the preceding day skiing, his urine was retested a week later. No albumin was found.)

Blood

Methods:

Sedimentation rate: Wintrobe method (56); values corrected for volume of packed red cells.

Cell counts: Adaptation of the method given by Wintrobe (56).

Hemoglobin: Measured colorimetrically as alkaline hematin with a Fisher electrophotometer by a modification of the Wintrobe method (56).

Sedimentation Rate

The sedimentation rate—the rate of settling of the red cells in samples of human blood treated to prevent clotting—varies in disease and under certain conditions of health. The rate is measured by the depth in millimeters that the corpuscles have settled in a vertical column of blood by the end of one hour (8, 56).

The sedimentation rate is usually increased in acute general infections. In localized acute inflammatory conditions, variations in sedimentation rate depend upon the nature and severity of the infection. The test is non-specific, but is a useful supplement to other clinical tests as a measure of the presence and intensity of infection.

The rate of sedimentation under normal conditions varies more in women than in men. Wintrobe (56) gives the normal ranges as 0 to 10 mm. per hour for men and 0 to 20 mm. per hour for women. Four-fifths of the values found in the Idaho study were in these normal ranges.

Table 11 gives the number of boys and girls whose sedimentation rates were above normal. An examination of the medical records of the 58 subjects whose sedimentation rates were above normal is of interest. "Colds"—recorded as nasal obstruction or discharge, red or swollen mucous membranes, pharyngitis, post nasal drip or laryngitis—were observed for 22 of these subjects. Thirteen of the subjects with high sedimentation rates were observed to have tonsillitis and 15, enlarged lymph nodes. White blood cell counts above 10,000 were found for 7 subjects with high sedimentation rates; heart murmur, 6 subjects; systolic pressure above 130, 5 subjects; abdominal tenderness, 3 subjects; albumin in urine, 2 subjects. These abnormal conditions, singly or in combination, accounted for only 42 of the 58 sedimentation rates which were above normal.

The medical examiner had noted that a few of the subjects with high sedimentation rates were "obese." The percentage deviation from standard weight of the subjects with high sedimentation rates

was checked. Twenty-two of the subjects—38 per cent of the group —were 10 per cent or more above standard weight. For 11 of the subjects, this was the only abnormal finding in the physical examination. The average sedimentation rate for the subjects who were overweight was then calculated and compared with the average rate for the subjects who were not overweight. Those subjects who had a high sedimentation rate and were observed to have some form of an infection were not included in either weight group. The 99 girls who were not overweight had an average sedimentation rate of 10.8; the 31 who were 10 per cent or more above standard weight had an average rate of 15.9. The 83 boys who were not overweight had an average sedimentation rate of 4.8; the 25 who were overweight had an average rate of 6.4. No report has been found in the literature indicating a relationship between sedimentation rate and overweight, but in this group of subjects the relationship seems to be too definite to be accidental.

White Blood Cell Counts

It is generally stated that the normal white blood cell (leukocyte) count is 5,000 to 10,000 cells per cmm. with an average of 7,000. Values above 10,000 are usually considered as representing leukocytosis. According to Wintrobe (56), however, a number of persons have a normal leukocyte count above 10,000; for others the count is normally well below 10,000 so that this figure in them indicates a pathological leukocytosis. Nineteen of the subjects in this study had white blood cell counts above 10,000 (Table 11).

Red Blood Cell Counts

The average number of red blood cells in man is usually given as 5,000,000 per cmm. for males and 4,500,000 for females. According to Best and Taylor (8), the actual values are about half a million higher. The values obtained by Wintrobe (56) from a compilation of all the accurate data available are 5.4 $\pm$ 0.8 million for males and 4.8 $\pm$ 0.6 million for females. The mean red cell counts of the subjects in this study were somewhat higher than these values, averaging approximately 5.6 million for the boys and 5.1 million for the girls.

Hemoglobin

Hemoglobin, the coloring matter of the red blood cells, carries oxygen from the lungs to the tissues. A deficiency of hemoglobin results in anemia. In the classification of hemoglobin values proposed by Bessey and Lowry (5) for children in the age group studied in Idaho, values below 11 gm. per 100 ml. for girls or 12 gm. per 100 ml. for boys were considered indicative of anemia. None of the Idaho subjects had hemoglobin values below these levels (Table 11). A higher percentage of the Nampa subjects than of Boise and Coeur d'Alene subjects had values in the range considered "Fair" by Bessey and Lowry, and fewer of the Nampa values were in the "Excellent" range.

Bone Density

X-ray films of a hand and foot of each subject were taken for bone density determinations by the Mack technique (10, 38). For bone density determinations, X-ray films are exposed with a specially designed standardized wedge placed beside the bone, the density of which is to be measured. (The calibration wedge used in this study was made of ivory, and resembled a tiny staircase. The ivory wedges have since been replaced by wedges of a special alloy.) To determine the bone density from such a film, a calibration curve is produced by measuring photoelectrically the light transmitted through various steps along the image of the wedge. The light transmitted through a prescribed path across the bone image on the same film is then measured and the density of the bone is calculated as grams of (X-ray equivalent) ivory per cubic centimeter of bone. The bone density results are computed and reported as an average "density coefficient" for the particular bone evaluated (39). The bone density determinations were made by the Bone Density Research and Evaluation Center at the Pennsylvania State University. In this study, the specific bones evaluated were the os calcis (heel-bone) and the phalanx 5-2 (middle section of the little finger).

This technique is relatively new, so standards for different age and sex groups have not yet been established. Data from the bone density determinations of the subjects who participated in the Western Regional nutritional status study in eight states (more than 2000 individuals) will be analyzed and reported on a regional basis. For this reason, the bone density determinations of the Idaho study will only be summarized briefly and will not be presented in detail in this report.

No important differences were found in the mean bone density values for the subjects from the three communities, so the environmental conditions which affect the teeth evidently do not affect bone mineralization as determined by this technique. The age and sex differences found were contradictory. The girls had somewhat higher mean values than the boys for the bone density readings of the finger-bone but not of the heel-bone. The children over 16 years of age had a higher mean value than the younger children for the bone density readings of the finger-bone but not of the heel-bone.

Blood Biochemical Tests

METHODS

Fasting venous blood samples were obtained during the forenoons. Hemoglobin, sedimentation rate, packed cell volume, and serum ascorbic acid determinations were made in the field clinic. Aliquots of the serums were frozen and sent to the laboratory to be analyzed for vitamin A, carotene, free and total riboflavin,

free and total cholesterol, alkaline phosphatase, iron and copper. Blood samples were obtained from 280 subjects, but for uncontrollable reasons not all determinations were made on all samples.

The methods used for determining the blood constituents are as follows:

Vitamin A and carotene: Bessey, Lowry, Brock and Lopez method (7).

Free and total riboflavin: Modified fluorometric method of Burch, Bessey and Lowry (13).

Ascorbic acid: Bessey method (4), using 20 cmm. of serum.

Free and total cholesterol: Determined on 1 ml. of serum by the Sperry and Webb method (44). The per cent of light transmission was read in a Model 6 Coleman Junior spectrophotometer at 625 mu.

Alkaline phosphatase: Bessey, Lowry and Brock method (6) using 20 cmm. of serum.

Hemoglobin: Measured colorimetrically as alkaline hematin with a Fisher electrophotometer by a modification of the Wintrobe method (56).

Packed cell volume and sedimentation rate: Wintrobe methods (56).

Iron: Hamilton, Gubler, Cartwright and Wintrobe method (32).

Copper: Gubler, Lahey, Ashenbrucker, Cartwright and Wintrobe method (28).

VALUES OF BLOOD CONSTITUENTS

Mean values,[4] standard deviations and ranges for the blood constituents and the number of subjects of each sex for whom the determinations were made are given in Table 12. Figure 4 shows the distribution by sex of the individual values for the biochemical blood constituents studied. The cumulative graphs readily show the percentage of values below any given level. Normal ranges are not indicated because there is need for more data before the lower and upper limits of normal for many of these blood constituents can be established.

Vitamin A and Carotene

The mean concentrations of serum vitamin A for the subjects in this study were similar to the mean values reported for subjects 13 to 19 years of age in Utah (53) but lower than those reported for subjects 14 to 16 years of age in Oregon (46). Mean values for students studied in the New York, Rhode Island and West Virginia phases of the northeastern regional nutritional status study were higher and those of the subjects in Maine were similar (18) to the Idaho values. In contrast, the mean serum carotene levels of the Idaho subjects were higher than those reported for the subjects in Oregon (46) and in the northeastern region except for the 16- to 20-year-old girls in Rhode Island and West Virginia

[4] Since there were unequal numbers of subjects in each group, the mean values by sex were adjusted statistically for area and age differences.

Table 12.—Means[1], standard deviations and ranges of blood constituents of Idaho boys and girls 15 and 16 years of age

Biochemical constituent	Sex	Number of subjects	Adjusted mean[1]	Standard deviation	Range
Serum					
Vitamin A (ug./100 ml.)	Boys	123	34.5	8.9	9.6-59.6
	Girls	150	31.5	9.4	8.3-60.3
Carotene (ug./100 ml.)	Boys	123	125.5	43.5	47.0-290.5
	Girls	150	122.1	41.0	13.5-286.0
Free riboflavin (ug./100 ml.)	Boys	124	0.63	0.39	0.06-2.78
	Girls	153	0.75	0.64	0.13-5.82
Total riboflavin (ug./100 ml.)	Boys	124	2.39	0.80	0.93-6.55
	Girls	154	2.40	0.84	1.03-8.21
Ascorbic acid (mg./100 ml.)	Boys	124	0.76	0.45	0.09-2.25
	Girls	142	1.01	0.54	0.14-2.40
Free cholesterol (mg./100 ml.)	Boys	124	41.1	8.0	25.5-69.9
	Girls	154	44.0	8.2	27.6-73.5
Total cholesterol (mg./100 ml.)	Boys	124	166.3	30.4	106.4-273.4
	Girls	154	175.3	31.1	109.2-291.6
Alkaline phosphatase (mmole. units/100 ml.)	Boys	121	4.14	1.81	0.95-10.79
	Girls	150	2.05	0.88	0.57-8.49
Iron (ug./100 ml.)	Boys	115	113.0	33.2	33-209
	Girls	141	104.8	43.3	31-361
Copper (ug./100 ml.)	Boys	122	112.1	20.6	64-170
	Girls	151	119.7	22.8	54-194
Whole blood					
Hemoglobin (gm./100 ml.)	Boys	126	15.4	1.0	12.8-17.2
	Girls	154	13.9	0.9	11.5-16.3
Packed cell volume (% volume)	Boys	126	47.6	2.8	40.0-53.0
	Girls	154	43.6	2.4	38.0-50.0
Sedimentation rate (mm./hr.)	Boys	125	6.9	5.7	0.0-34.0
	Girls	152	14.1	8.0	1.0-36.0

[1] Means adjusted for age and area differences in unequal number of subsamples.

(18). The Utah teen-age subjects (53) had higher mean serum carotene values than the Idaho subjects.

Serum vitamin A values below 20 ug./100 ml. were considered indicative of a "poor" level of nutrition by Bessey and Lowry (5). Only 6 per cent of the boys and 11 per cent of the girls had values below 20 ug./100 ml.

Bessey and Lowry (5) classified serum carotene values below 75 and 125 ug./100 ml. as "poor" and "fair," respectively. Clayton *et al.* (18) found that many of the values for the northeastern subjects fell below 125 ug./100 ml., so they classified levels between 75 and 100 ug./100 ml. as "fair." Nearly one-third of the Idaho subjects had serum carotene values below 100 ug./100 ml., but only 10 per cent of the boys and 5 per cent of the girls had values below 75 ug./100 ml.

Riboflavin

The mean serum riboflavin values in the present study were similar to those found in fasting blood samples in comparable studies of normal subjects in Utah (53) and Washington (27). Bessey and Lowry (5) defined values below 2.5 ug./100 ml. of serum total riboflavin as indicative of a "poor" level of nutrition. The blood samples in that study were drawn without respect to meals eaten, which may account for the values being substantially higher than those found in fasting samples in the present study.

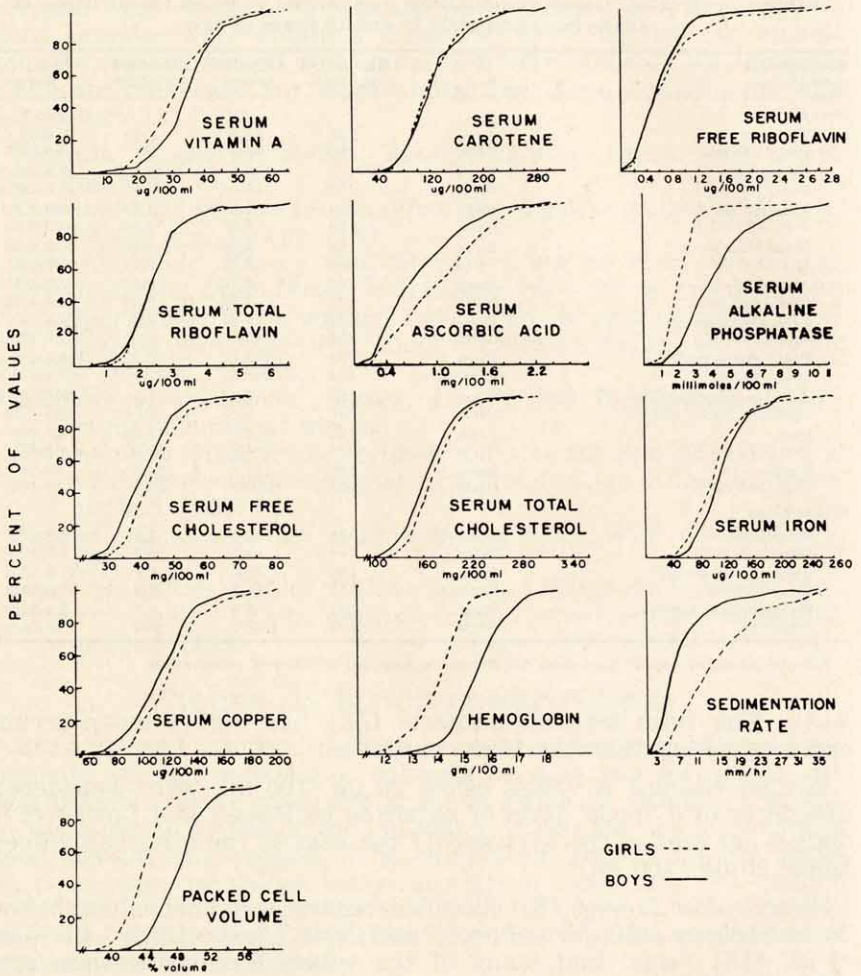

Figure 4. Percentages of subjects with values for 13 biochemical factors below the levels indicated.

Over 60 per cent of the Idaho subjects had serum total riboflavin values below 2.5 ug./100 ml., although only 6 per cent of the boys and 15 per cent of the girls reported food intakes which supplied less than two-thirds of the National Research Council's recommended dietary allowances of riboflavin.

Ascorbic Acid

The mean serum ascorbic acid values were similar to or higher than those reported for the subjects studied in Oregon (46), New Mexico (14) and for all groups of teen-age subjects in the northeastern region except the West Virginia college girls (18). Boys

studied in Utah (53) had higher mean ascorbic acid values than the Idaho boys.

The serum level of ascorbic acid reflects the recent level of intake, but serum levels below 0.4 mg./100 ml. were considered by Bessey and Lowry (5) as indicative of a "poor" level of nutrition. Twenty-five per cent of the Idaho boys and 16 per cent of the girls had values below 0.4 mg./100 ml.

Cholesterol

Kornerup (37) reported higher mean serum free and total cholesterol values for 14- and 16-year-old children than were found in this study. Wilcox *et al.* (53) reported slightly lower mean serum total cholesterol values but similar serum free cholesterol values for Utah subjects 13 to 16 years of age.

Muller (41) reported normal values of plasma total cholesterol from 150 to 180 mg./100 ml. Values above 180 mg./100 ml. were found for 31 per cent of the Idaho boys and 39 per cent of the girls; values above 200 mg./100 ml. were found for 13 per cent of the boys and 18 per cent of the girls.

Phosphatase

The mean serum alkaline phosphatase values for the Idaho boys and girls were 4.14 and 2.05 millimole units/100 ml., respectively. Harrison and co-workers (33) reported similar mean values for 15- and 16-year-old girls but higher mean values for boys of the same age. The mean levels of the present study were similar to those reported for Utah subjects (53), somewhat higher than those reported by Bessey and Lowry (5), and lower than those for Maine and New York subjects (18).

One per cent of the 1200 New York school children studied by Bessey and Lowry (5) had serum alkaline phosphatase values above 8 millimole units/100 ml., which they classified as "unsatisfactory." In Idaho the same percentage of girls, but 5 per cent of the boys had values above this criterion.

Iron

The mean serum iron values in this study were higher than the values reported by Schlaphoff *et al.* (43) for samples drawn in the afternoon. Vahlquist (48) and Dahl (20) reported higher values for teen-age girls, but they did not report the time the samples were taken.

Cartwright and Wintrobe (16) suggested 44 to 215 ug./100 ml. as the normal range of serum iron values. Only 2 per cent of the Idaho subjects had serum iron values below 44 ug./100 ml.

Copper

The mean serum copper values for the subjects in the Idaho study were somewhat lower than Cartwright *et al.* (15) reported for adults.

Cartwright and Wintrobe (16) gave the normal range of serum

copper values as 85 to 160 ug./100 ml. In the Idaho study, 13 per cent of the boys and 3 per cent of the girls had values below this range, 2 per cent of the boys and 6 per cent of the girls had values above.

Hemoglobin

The mean hemoglobin values were slightly higher than those reported for the Oregon subjects (46) and for most of the adolescent groups studied in the northeastern region (18).

Bessey and Lowry (5) considered hemoglobin values between 12 and 14 gm./100 ml. for boys over 14 years of age and between 11 and 13 gm./100 ml. for girls indicative of a "fair" level of nutrition. Six per cent of the Idaho boys and 16 per cent of the girls had hemoglobin values in these ranges; none had lower values.

Volume of Packed Cells

The mean packed cell volume found in this study is in good agreement with the averages reported by Wintrobe (56) for boys and girls of this age group. None of the Idaho boys and only 5 per cent of the girls had less than 40 per cent volume of packed cells.

Sedimentation Rate

Sedimentation rates above 10 mm./hr. for boys and above 20 mm./hr. for girls were designated as being above normal by Wintrobe (56). Eighteen per cent of the boys and 24 per cent of the girls in this study had sedimentation rates above normal. Acute general infections, some chronic infections and some localized acute infections are accompanied by an increase in sedimentation rate (56). Nearly three-fourths of the Idaho subjects with high sedimentation rates were observed by the examining physicians to have colds, tonsillitis or a similar infection. Thirty-eight per cent of the subjects with high sedimentation rates were 10 per cent or more above standard weight; for 19 per cent of the subjects with high sedimentation rates, overweight was the only abnormal finding in the physical examination.

SEX, AGE AND AREA DIFFERENCES

For each blood constituent, mean values for the subjects grouped by sex, age and area are presented in Table 13. Because it was impossible to secure data from equal numbers of subjects of each age and sex group in each area, the means were adjusted statistically to compensate for the different numbers of subjects in the groupings. For each of the blood constituents, the difference is given between the means for boys and girls, for subjects 15 and 16 years of age, and for each of the area comparisons. The smallest mean difference required for significance at the 5 per cent level of probability (the least significant difference) is shown for each comparison by sex and age. The least significant difference between the means of the area comparison involving the smallest number of subjects is given. (For the area comparisons involving

Table 13.—Means[1] of blood constituents of Idaho subjects classified by sex, age and area with difference required for significance at the 5 per cent level of probability

	Serum										Whole blood		
	Vitamin A	Carotene	Riboflavin Free	Riboflavin Total	Ascorbic acid	Cholesterol Free	Cholesterol Total	Alkaline phosphatase	Iron	Copper	Hemoglobin	Packed cell volume	Sedimentation rate
	ug./100 ml.	ug./100 ml.	ug./100 ml.		mg./100 ml.	mg./100 ml.		mmole. units/100 ml.	ug./100 ml.	ug./100 ml.	gm./100 ml.	%	mm./hr.
Sex													
Boys	34.5	125.5	0.63	2.39	0.76	41.1	166.3	4.14	113.0	112.1	15.4	47.6	6.9
Girls	31.5	122.1	0.75	2.40	1.01	44.0	175.3	2.05	104.8	119.7	13.9	43.6	14.1
Difference	−3.0*	−3.4	0.12	0.01	0.25**	2.9**	9.0*	−2.09**	−8.2	7.6**	−1.5**	−4.0**	7.2**
L. S. D.[2] (5%)	2.2	10.2	0.13	0.19	0.12	1.9	7.3	0.36	9.8	5.3	0.2	0.6	1.7
Age (years)													
15	33.1	125.1	0.66	2.44	0.93	43.2	173.9	3.61	109.8	116.7	14.6	45.6	9.9
16	32.9	122.5	0.71	2.34	0.85	42.0	167.7	2.58	108.1	115.1	14.7	45.6	11.2
Difference	0.2	2.6	−.05	0.10	0.08	1.2	6.2	1.03**	1.7	1.6	−0.1	00.0	−1.3
L. S. D.[2] (5%)	2.2	10.1	0.13	0.19	0.12	1.9	7.2	0.36	9.8	5.3	0.2	0.6	1.7
Area													
Boise	33.5	128.3	0.71	2.35	0.81	43.5	171.5	2.89	117.8	121.9	14.9	46.6	10.1
Nampa	32.2	132.1	0.76	2.53	0.88	43.0	173.8	3.05	109.6	118.8	14.2	45.2	10.4
Coeur d'Alene	33.3	111.0	0.59	2.30	0.97	41.2	167.0	3.33	99.5	106.9	15.0	45.0	11.0
Difference													
Boise-Nampa	1.3	3.8	0.05	0.18	0.07	0.5	2.3	0.16	8.2	3.1	0.7**	1.4**	0.3
Coeur d'Alene-Nampa	1.1	21.1**	0.17*	0.23	0.09	1.8	6.8	0.28	10.1	11.9**	0.8**	0.2	0.6
Coeur d'Alene-Boise	0.2	17.3**	0.12	0.05	0.16*	2.3	4.5	0.44*	18.3**	15.0**	0.1	1.6**	0.9
L. S. D.[3] (5%)	2.7	12.5	0.16	0.24	0.15	2.4	8.9	0.45	12.4	−6.6	0.3	0.8	2.1

[1] Means adjusted for unequal subclass numbers.
[2] Least significant mean difference.
[3] L. S. D. between area comparisons based on smallest number of subjects.
* Difference between mean significant at 5% level of probability.
** Difference between mean significant at 1% level of probability.

larger numbers of subjects, a smaller mean difference would be significant.) In the following discussion, all differences described as significant were statistically significant at the 1 per cent level of probability unless it is specifically stated that the difference was significant at only the 5 per cent level of probability.

The mean values for the boys were significantly higher than for the girls in serum alkaline phosphatase, hemoglobin and packed cell volume. The mean values for the girls were significantly higher than for the boys in serum ascorbic acid, serum free cholesterol, serum copper and sedimentation rate. Other workers (5, 15, 18, 33, 40) have reported similar sex differences in the mean serum levels of one or more of these blood constituents.

The only statistically significant difference between age groups in this study was found in serum alkaline phosphatase values, with the mean value for the younger subjects being higher than for the older subjects. Similar age differences in serum alkaline phosphatase values have been reported by Bessey and Lowry (5) and Harrison *et al.* (33).

Area differences were noted in the values of several of the blood constituents. The subjects studied in Coeur d'Alene had significantly lower mean serum carotene and mean serum copper values than those studied in Boise and Nampa. The Coeur d'Alene subjects had a mean serum iron value significantly lower than the value for the Boise subjects. The Nampa group had a mean hemoglobin value significantly lower than the means of the other two groups. The Boise subjects had a mean packed cell volume significantly higher than the means of the other two groups. Of these area differences, only those in serum carotene and serum copper can be considered regional differences. Had this study been done in only one of the southwestern towns and Coeur d'Alene, all differences between communities might have been attributed to geographic differences.

CORRELATIONS

Table 14 gives the correlation coefficients among all comparisons of blood constituents studied for the boys and for the girls. Corrections were made for area differences in all correlations and for age differences in all correlations involving serum alkaline phosphatase. Highly significant positive correlations were found for both boys and girls between the following constituents of whole blood or serum: vitamin A and carotene; free and total riboflavin; free and total cholesterol; hemoglobin and packed cell volume; carotene and ascorbic acid; vitamin A and both free and total cholesterol; carotene and both free and total cholesterol; copper and sedimentation rate.

The first four of these correlations would be expected. The correlation between serum carotene and serum ascorbic acid might be explained by their common food sources—fruits and vege-

Table 14.—Correlation coefficients[1] among blood constituents of Idaho boys and girls 15 and 16 years of age

Biochemical constituents[2]	Sex	Serum							Whole blood				
		Caro-tene	Riboflavin Free	Riboflavin Total	Ascorbic acid	Cholesterol Free	Cholesterol Total	Alkaline phospha-tase	Iron	Copper	Hemo-globin	Packed cell volume	Sedimenta-tion rate
Serum													
Vitamin A	Boys	0.29**	0.24**	0.31**	0.07	0.30**	0.30**	−0.32**	0.34**	−0.18*	0.15	0.12	0.02
	Girls	0.27**	0.05	0.04	0.02	0.22**	0.26**	0.08	0.03	0.07	0.16	0.14	−0.11
Carotene	Boys		0.35**	0.25**	0.27**	0.38**	0.35**	−0.07	0.18	−0.10	0.15	0.18*	0.05
	Girls		0.03	0.18*	0.39**	0.29**	0.29**	0.18	0.11	−0.00	−0.06	0.19*	−0.04
Free riboflavin	Boys			0.58**	0.24**	−0.01	0.01	−0.15	0.18	−0.14	0.02	−0.02	0.00
	Girls			0.75**	−0.11	0.03	0.03	−0.08	−0.02	−0.12	−0.04	−0.08	−0.12
Total riboflavin	Boys				0.07	0.22*	0.22*	−0.10	0.16	−0.12	0.10	0.11	−0.07
	Girls				−0.09	0.19*	0.18*	0.04	0.06	−0.12	−0.03	−0.01	−0.07
Ascorbic acid	Boys					−0.00	−0.03	−0.09	0.27**	−0.08	0.12	0.13	0.10
	Girls					0.08	−0.10	0.14	0.01	0.04	−0.18*	−0.10	−0.06
Free cholesterol	Boys						0.97**	−0.08	0.26**	−0.02	0.17	0.20*	−0.02
	Girls						0.97**	0.13	0.05	0.25**	0.13	0.18*	0.20*
Total cholesterol	Boys							−0.08	0.29**	−0.04	0.21*	0.24**	−0.03
	Girls							0.11	0.01	0.21*	0.18*	0.18*	0.17*
Alkaline phosphatase[3]	Boys								−0.21*	0.12	−0.36**	−0.35**	0.02
	Girls								0.04	0.05	0.09	0.02	0.01
Iron	Boys									−0.09	0.39**	0.34**	−0.09
	Girls									−0.17*	0.16	0.10	−0.19*
Copper	Boys										−0.02	0.01	0.49**
	Girls										0.05	0.08	0.40**
Whole blood													
Hemoglobin	Boys											0.81**	−0.04
	Girls											0.49**	0.08
Packed cell volume	Boys												−0.08
	Girls												0.08

[1] $r = \frac{\text{covariance}}{\text{geometric mean of variance}}$; degrees of freedom for sums of products ranged from 111 to 123 for boys, 127 to 151 for girls; degrees of freedom for sums of squares ranged from 112 to 123 for boys, 138 to 151 for girls.

[2] All correlation coefficients were corrected for area differences.

[3] All correlation coefficients involving serum alkaline phosphatase were corrected for age differences.

* Significant at the 5% level of probability.

** Significant at the 1% level of probability.

tables supply the major portions of these two vitamins. Highly significant positive correlations between serum vitamin A and serum carotene and between serum carotene and serum ascorbic acid were also reported by Babcock *et al.* (1) for the adolescents studied in the northwestern region and by Storvick *et al.* (46) for the Oregon study. Vitamin A and cholesterol are fat-related compounds, so a metabolic relationship between them might be expected. Serum carotene also appears to be involved in this relationship. Collazo *et al.* (19) reported that rats fed a vitamin A-deficient diet exhibited a considerable decrease in total cholesterol levels, while those given excess doses of vitamin A showed an increase in serum total cholesterol.

In acute and chronic infectious diseases, elevated serum copper values have been reported by a number of workers (16, 48). Since the sedimentation rate usually also increases in the presence of infection, this would explain the correlation between these blood constituents.

No significant correlation was found in the Idaho study between serum vitamin A and ascorbic acid. A positive correlation was reported between these factors in the studies of school children in New York (1) and Oregon (46), and a negative correlation was reported in the study of college students in West Virginia (1). In the present study, significant correlations were not found between serum vitamin A and hemoglobin or between serum vitamin A and packed cell volume, as were reported in the Oregon study (46). However, in the studies in Oregon (46) and the northeastern region (1), the correlation coefficients were calculated using the combined data for both sexes.

In many of the comparisons among whole blood and serum constituents in the Idaho study only the data of the boys showed highly significant correlations. This was true for the positive correlations between vitamin A and both free and total riboflavin, vitamin A and iron, carotene and both free and total riboflavin, free riboflavin and ascorbic acid, ascorbic acid and iron, iron and both free and total cholesterol, total cholesterol and packed cell volume, iron and hemoglobin, iron and packed cell volume, and for the negative correlations between alkaline phosphatase and each of the following: vitamin A, hemoglobin and packed cell volume. Only the correlation between serum free cholesterol and serum copper was highly significant for the girls alone.

In the light of present knowledge, there seems to be no reason for finding so many significant relationships between biochemical blood constituents of the boys but not of the girls. Some may be chance relationships only. Further work is needed to clarify these findings of sex differences.

Dietary Studies

DIET HISTORIES

The nutritionists interviewed each subject to obtain information about his customary eating patterns, production and preservation of food by his family for home use, his food likes and dislikes, and also to tell the subject how to measure and record his food intake on the daily food records.

Eighty-two per cent of the teen-age school children interviewed in this study usually ate breakfast, noon meal, evening meal and one or more snacks. Only 2 per cent stated that they usually did not eat lunch, 7 per cent that they skipped breakfast and 9 per cent that they usually did not have a snack. The type of lunch eaten on school days varied by community. Nearly two-thirds of the Nampa subjects ate at the school cafeteria, but in the Boise and Coeur d'Alene areas most of the subjects carried a lunch to school or ate at home.

Type of Lunch	Per cent of subjects in		
	Boise	Nampa	Coeur d'Alene
Lunch at home	35	18	37
School cafeteria	5	65	5
Carried lunch to school	46	9	53
Restaurant	12	6	4
No lunch	2	2	1

Production and Preservation of Food

In the diet history interview, the nutritionists asked the subjects what vegetables, fruits and meats were customarily produced or preserved for home use by his family. The answers obtained are summarized in Tables 15, 16 and 17.

Table 15.—Number of subjects in three Idaho communities who stated in the diet history interviews that their families customarily produced or preserved certain vegetables for home use

Vegetable	Produced			Canned			Frozen		
	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene
Asparagus	7	31	5	1	6	2	3	6	2
Beans	28	52	56	39	48	53	8	20	19
Beets	17	41	31	13	26	24	0	0	2
Cabbage	13	43	43	....	....	....	....	....	....
Carrots	28	59	72	8	7	21	3	2	7
Cauliflower or broccoli	6	32	9	1	5	3	1	1	2
Corn	24	49	35	20	34	35	22	52	37
Cucumbers	10	31	6	11	17	4	....	....	....
Greens	14	33	30	5	5	5	2	0	4
Lettuce	16	44	57	....	....	....	....	....	....
Onions	13	35	19	....	....	....	....	....	....
Peas	26	52	48	17	21	36	15	35	23
Potatoes	17	47	53	....	....	....	....	....	....
Radishes	22	36	27	....	....	....	....	....	....
Squash or pumpkin	11	34	7	1	5	0	3	0	1
Tomatoes	37	58	46	60	67	50	....	....	....
None	46	30	22	24	22	24	65	43	45

Vegetables: (Table 15)

A larger number of subjects in Coeur d'Alene than in the other areas stated that their families customarily raised some vegetables —74 in Coeur d'Alene, 62 in Nampa and 41 in Boise. The vegetable gardens which were raised in the Nampa area tended to be larger than in the other areas, however—30 Nampa subjects but only 8 Boise subjects and 4 Coeur d'Alene subjects stated that their families raised more than 10 kinds of vegetables. Tomatoes, carrots, beans, peas and corn were the five vegetables raised by the largest number of these families in both Boise and Nampa. In Coeur d'Alene, lettuce and potatoes replaced tomatoes and corn in the group of the five most commonly raised vegetables. One-tenth or less of these families in Boise and Coeur d'Alene raised squash or pumpkins, broccoli or cauliflower, asparagus and cucumbers, but approximately one-third of the Nampa families raised these vegetables.

In each area, approximately three-fourths of the families represented by these subjects preserved some vegetables by canning. Tomatoes and green beans were the vegetables most commonly canned. Less than one-third of the families in the Boise area but somewhat over one-half of the families in the Nampa and Coeur d'Alene areas preserved some vegetables by freezing. Corn and peas were the vegetables most commonly frozen. No vegetables were preserved by 18 of these families in Boise, 13 in Nampa and 14 in Coeur d'Alene.

Table 16.—Number of subjects in three Idaho communities who stated in the diet history interviews that their families customarily produced or preserved certain fruits for home use

Fruit	Produced			Canned			Frozen		
	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene
Apples	20	19	36	23	25	33	2	1	3
Apricots	17	23	0	46	66	63	2	2	3
Cherries	12	26	20	49	74	69	6	18	19
Huckleberries	....	....	....	2	11	8	1	0	29
Peaches	18	28	4	78	95	82	9	14	10
Pears	10	14	14	59	75	72	2	1	4
Plums	12	22	23	30	49	48	2	0	5
Raspberries or blackberries	31	43	45	39	42	34	16	31	50
Rhubarb	0	6	1	1	10	4	1	1	1
Strawberries	27	40	57	27	33	20	21	47	45
Others—principally melons or grapes	5	14	4	6	10	1	0	2	4
None	34	27	23	10	3	11	66	46	27

Fruits: (Table 16)

Three-fifths of the Boise families and four-fifths of the Nampa and Coeur d'Alene families customarily raised some fruit for home use. Strawberries and raspberries or blackberries were the fruits most commonly raised in each area. Definitely more families in Coeur d'Alene than in the other areas raised strawberries and apples. In the Coeur d'Alene area only four families raised peaches and none raised apricots; one-third of the families which did raise fruit in Boise and Nampa raised peaches and apricots.

Nearly all of the families represented in this study preserved some fruits by canning. Peaches, pears, cherries and apricots were the fruits most commonly canned. More families canned than produced all the fruits except strawberries and raspberries or blackberries. Far more of these families preserved fruits by canning than by freezing, with the exception of all types of berries in Coeur d'Alene and strawberries in Nampa. No fruits were preserved by 7 of these families in Boise, 3 in Nampa and 7 in Coeur d'Alene.

Table 17.—Number of subjects in three Idaho communities who stated in the diet history interviews that their families customarily produced or preserved certain meats or dairy products for home use

Meat or dairy product	Produced			Canned			Frozen		
	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene	Boise	Nampa	Coeur d'Alene
Beef	5	26	28	4	2	6	25	60	55
Pork	6	21	14	0	1	2	18	36	37
Chicken, other fowl	25	38	34	6	3	3	33	27	38
Rabbit	7	2	5	....	....	....	....	....	....
Venison or elk	....	....	....	2	0	4	27	39	48
Fish	....	....	....	0	0	13	13	13	28
No meats	64	55	60	83	96	73	42	26	24
Eggs	24	35	36	....	....	....	....	....	....
Milk	13	38	26	....	....	....	....	....	....
Butter	10	23	17	....	....	....	....	....	....
Cheese	4	1	8	....	....	....	....	....	....

Meats: (Table 17)

More families in Nampa and Coeur d'Alene than in Boise produced meat for home use. The meat most commonly produced by these families in each area was chicken. Few families in any of these areas preserved meat by canning, but one-half of the families in the Boise area and approximately three-fourths in Nampa and Coeur d'Alene preserved meats by freezing. Beef and venison or elk were the meats most commonly frozen in Nampa and Coeur d'Alene, chicken and venison or elk were the meats most commonly frozen by these families in Boise.

Use of Freezing Facilities:

In each area, more subjects reported that their families froze meats than froze fruits or vegetables. Most of the families which did preserve some fruits or vegetables by freezing, froze only one or two kinds. The number of families freezing meats, fruits and vegetables is as follows:

	Boise	Nampa	Coeur d'Alene
Meats	52	74	72
Fruits	28	54	69
More than 2 fruits	8	15	32
Vegetables	29	57	51
More than 2 vegetables	6	16	9

Particularly in Boise and Nampa, many home freezers or freezing lockers were evidently being used only for meats. For those families which were using the freezing space only for meat or were freezing only one or two kinds of fruits or vegetables, freez-

ing the surplus fruits and vegetables produced at home or those readily available on the market would be a convenient and inexpensive way of providing the fruits and vegetables for use during other seasons.

Food Likes and Dislikes

The nutritionists asked the subjects, "What are your favorite foods?" and "What foods do you dislike?" In tabulating the responses, no attention was paid to the order in which the foods were listed by a subject, because it was felt that for most of the subjects the order in which the foods were mentioned did not indicate rank of preference or dislike. Some subjects mentioned only one food in answer to each question; some listed two or three. Some subjects named a whole class of foods, such as "sweets" or "vegetables," while others gave specific answers such as "cooked celery" or "stuffed peppers." Foods mentioned by five or more subjects, either as being liked or disliked, are listed in Table 18.

Table 18.—Foods mentioned as being liked or disliked by five or more subjects in the diet history interviews

Food group	Food	Liked	Disliked
Milk products	Milk	8	9
	Ice cream	8	1
	Cottage cheese	5	11
Cereals	Macaroni, spaghetti	27	3
	Rice	4	1
Protein foods	Meat	26	3
	Steak	18	0
	Chicken	19	4
	Pork	10	1
	Hamburger	8	0
	Tuna fish	5	1
	Fish	0	5
	Liver	2	46
	Other meats	14	10
	Chili	7	2
	Eggs	2	9
Citrus fruits or alternate sources of ascorbic acid	Tomatoes	3	8
	Oranges	4	1
	Cabbage	1	27
Green and yellow vegetables	Sweet potatoes	3	7
	Broccoli	1	6
	Squash	0	8
	Carrots	3	11
	Peas	2	14
	Spinach	9	42
	Asparagus	2	46
Other fruits and vegetables	Fruit	14	0
	Vegetables	15	6
	Potatoes	49	2
	Apples	7	0
	Bananas	5	2
	Corn	10	9
	Onions	0	6
	Beets	1	10
	Parsnips	1	12
	Turnips	0	11
	Cauliflower	0	21
	Other fruits	8	10
	Other vegetables	11	27
	Salads	12	3
Sweets	Sweets	14	1
	Pie	12	2
	Cake	7	0
	Chocolate	5	1
	Other sweets	6	3
Accessories	Gravy	16	0

Potatoes were named as a favorite food by the largest number of subjects. Asparagus, cabbage and liver were the foods most frequently mentioned as being disliked.

Fruits in general were mentioned more often as being liked than as being disliked; vegetables, other than potatoes, were mentioned more often as being disliked. Green and yellow vegetables were listed as being disliked nine times oftener than as being liked. Protein foods, with the exception of liver, were mentioned as being liked four times more frequently than they were listed as being disliked. Milk products other than ice cream were listed oftener as being disliked than as being liked. Sweets and cereals were listed five or six times more frequently as being liked than as being disliked.

It is perhaps surprising that no subject in this group of teenage school children mentioned soft drinks as a favorite food. Sweets as a group were mentioned only 44 times as favorite foods, compared with fruits and vegetables which were mentioned 161 times and meats which were mentioned 101 times as favorite foods.

Estimated Frequency of Eating Certain Foods

The subjects were asked how frequently they ate certain foods and how much they usually ate. For some of these foods, the estimated frequencies and amounts were later compared with the information from the daily food records kept by the subjects for 7 days following the diet history interview. The subjects estimated that they ate these foods more frequently or in larger amounts than was shown by the diet records; the difference between the estimated and recorded amount was small for some foods but large for others. The average number of eggs eaten per week, according to the diet histories, was 5 per week; the recorded egg consumption averaged 4 per week. The estimate of the amount of milk drunk was 50 per cent higher than the recorded amount. According to the diet histories, the average amount of milk per person was 27.5 cups per week; the recorded amounts averaged 18.0 cups per week. In the interview, only 9 per cent of the subjects gave their usual weekly intake of milk as less than 14 cups (one pint a day). The food records showed that 29 per cent of the subjects drank less than 14 cups of milk a week.

Only 11 to 15 per cent of the subjects in each area estimated that they averaged less than one serving per day of green or yellow vegetables. Over one-half of the Boise subjects and three-fourths of the Nampa and Coeur d'Alene subjects stated that they had more than one serving per day. The actual quantities of green and yellow vegetables reported in the food records were well below the amounts the diet history estimates would indicate—Boise, 3.2 cups: Nampa, 2.8 cups; Coeur d'Alene. 3.1 cups per person per week. Although over four-fifths of the subjects thought that they had a serving of green or yellow vegetables at least once a day, only 15 per cent reported servings seven or more times a week. The first part of Figure 5 shows the comparison between the number

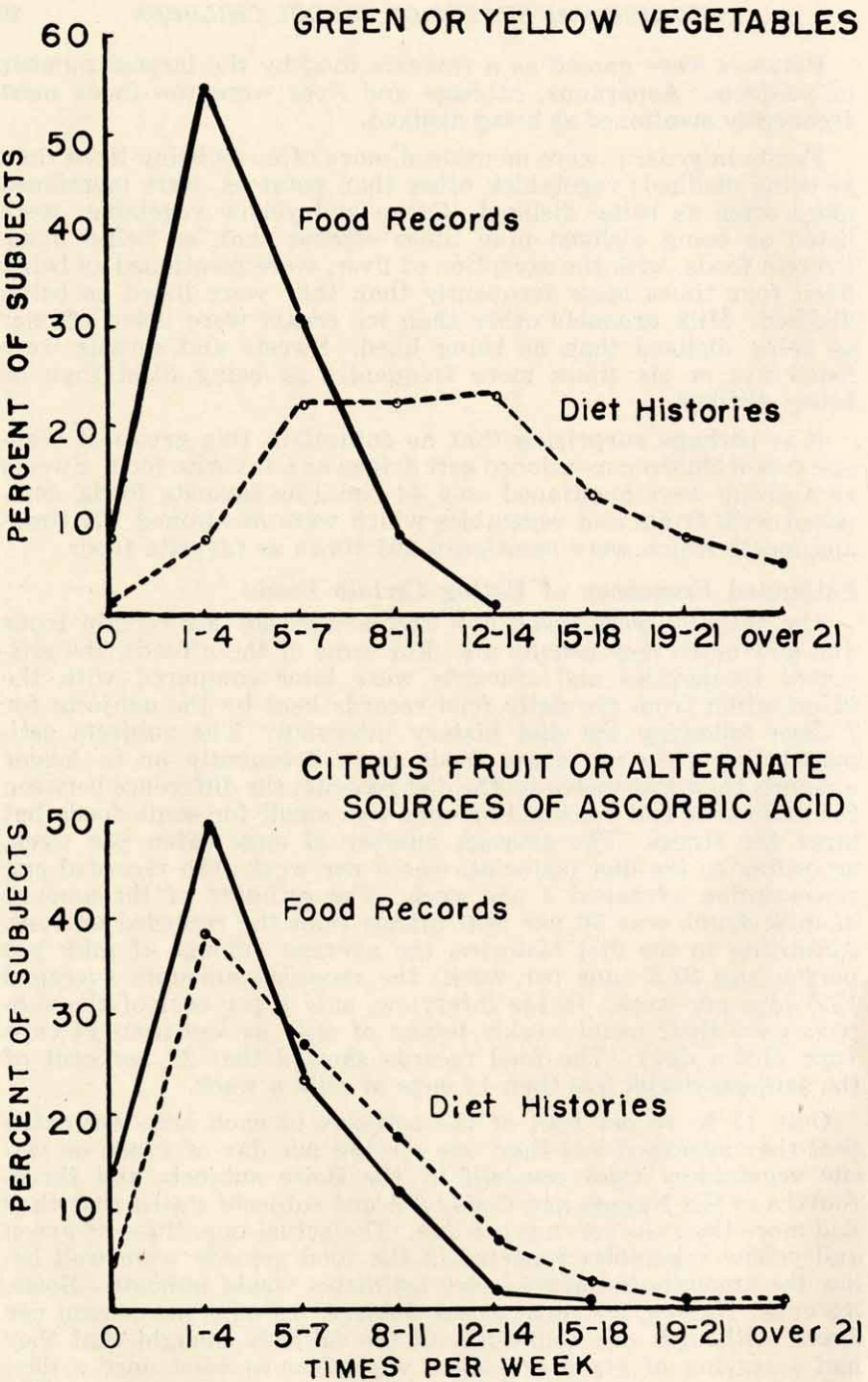

Figure 5. Comparisons of the estimated and reported number of times per week that the subjects ate two types of fruits and vegetables.

of times per week that the subjects estimated that they ate green or yellow vegetables and the number of meals in which these foods were reported in the food records.

Three-fifths of the subjects in Boise and Nampa stated that they had a serving of citrus fruit or an alternate source of ascorbic acid less often than once a day, but over one-half of the Coeur d'Alene subjects stated that they had more than seven servings a week of ascorbic-acid-rich foods. The actual intake as reported in the food records was highest for the Coeur d'Alene subjects, but only slightly higher than for the Nampa subjects—Coeur d'Alene, 4.2 cups; Nampa, 3.9 cups; Boise, 3.1 cups per person per week.

The second part of Figure 5 shows the comparison between the estimated and reported number of times per week that the subjects ate citrus fruit or alternate sources of ascorbic acid. The differences between the estimated and reported frequencies of eating foods in this group are much smaller than in the similar comparison for green or yellow vegetables.

Diet Appraisals

After the nutritionist had finished the diet history interview, she estimated whether the subject's diet would furnish 80 per cent of the National Research Council's 1948 recommended dietary allowances (25) of eight nutrients, for a person of that sex and age. There were two principal sources of error in such an appraisal —the tendency of the subjects to overestimate the amounts of certain foods eaten, and the tendency of the nutritionist to underestimate the nutrient content of the diet because only the principal sources of the different nutrients were considered in making the rapid appraisal. The latter source of error was more important for a nutrient like thiamine, which is present in many foods in small amounts, than for nutrients like riboflavin and ascorbic acid, the major portions of which are supplied in the diet by one food or one food group.

More than one-half of the diets were appraised as furnishing less than 80 per cent of the recommended dietary allowances of thiamine, ascorbic acid and iron. Iron was judged to be low in the largest percentage of the diets of the girls (88 per cent) and ascorbic acid to be low in the largest percentage of the diets of the boys (80 per cent). From 18 to 35 per cent of the diets were judged to furnish less than 80 per cent of the recommended dietary allowances of the other nutrients considered in this part of the study—riboflavin, protein, vitamin A, calcium and niacin, in order of increasing percentages of diets judged to be low in the respective nutrients. A higher percentage of the diets of the girls than of the boys were appraised as being low in all nutrients except ascorbic acid.

The nutrient content of the diets as recorded in the 7-day food records was calculated and the percentage of the diets which furnished less than 80 per cent of the recommended dietary allowance of each of these nutrients was determined. Figure 6 shows the

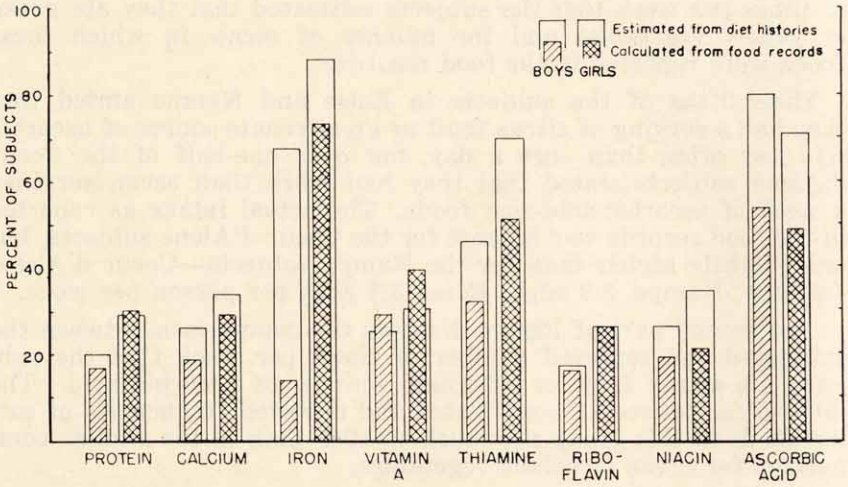

Figure 6. Comparison of the percentage of subjects whose diets furnished less than 80 per cent of the 1948 recommended dietary allowances of eight nutrients, as estimated from the diet histories and as calculated from the food records.

comparison of the percentage of subjects whose diets furnished less than 80 per cent of the recommended dietary allowances of eight nutrients, as estimated from the diet histories and as calculated from the food records.

The percentage of subjects whose diets furnished less than 80 per cent of the recommended dietary allowances was lower as calculated from the food records than as estimated from the diet histories for all nutrients except vitamin A. The estimate of the vitamin A intake was based largely on the number of servings of green and yellow vegetables which the subjects said they usually had, which proved to be much greater than the actual number eaten. Although the milk intake was also estimated to be much greater than the actual intake, the actual intake was high enough so that most of the diets did furnish an adequate amount of riboflavin and calcium.

The greatest difference between the percentage of diets estimated and calculated to be low in a nutrient was in iron for the boys. On the basis of the diet histories, two-thirds of the boys' diets were estimated to be low in iron, but only 13 per cent of the boys' 7-day food records were calculated to furnish less than 80 per cent of the recommended dietary allowance of iron. Few of the subjects said that they ate the rich sources of iron, such as liver, often enough to assure a high iron intake. The contribution of foods fairly low in iron but eaten in large quantities, such as cereals, to the total dietary intake was not fully recognized in appraising the boys' diets; most of the girls did not eat large quantities of these foods.

In spite of the errors inherent in appraising the quality of diets from information obtained in interviews, for this group of subjects the same general conclusions could be reached on the basis of the diet history appraisal as by calculation of the food records (except concerning the iron intake of the boys). The iron intake of the girls and the thiamine and ascorbic acid intake of both the boys and girls were low for more of the subjects than were the intakes of the other nutrients. In general, more of the girls' than of the boys' diets furnished less than 80 per cent of the recommended dietary allowances of the nutrients studied.

NUTRIENT INTAKE

During the interview with the nutritionist, each subject received instructions on recording his daily food intake. The quantities of foods eaten were to be recorded in common household measures (cups, tablespoons, teaspoons, inches or other units where applicable). The nutritionist emphasized that the subject was to eat just as he would if he were not keeping a record of the food eaten. Written instructions and forms for keeping the diet records for 7 days were given to the subjects, with self-addressed stamped envelopes in which to return each record as completed.

A total of 150 girls and 124 boys completed their dietary records. The subjects in Boise and Nampa kept their records during January, February or March, and those in the Coeur d'Alene area during April or May of 1951.

The individual diet records were tabulated in terms of portions reported per week. Nutrient content was calculated by punch cards, using the values in the United States Department of Agriculture Handbook 8, *Composition of Foods,* Table III (49). Values for certain mixed dishes were calculated or obtained from other sources (11, 12).

Average Nutrient Intake

The average daily intake of calories, protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin and ascorbic acid for the boys and girls in each area is given in Table 19. The average daily intakes of these nutrients were similar for the subjects in each area, in spite of geographic, occupational and other environmental differences in the communities studied. The differences in the average daily intakes by sex were definite in each community. The average daily intake of all nutrients except vitamin A and ascorbic acid was at least 45 per cent higher for the boys than for the girls. The average daily intake of vitamin A was only 26 per cent and of ascorbic acid 16 per cent higher for the boys than for the girls.

A measure of the adequacy of the diets of these subjects was obtained by comparing the average intakes with the National Research Council's 1948 recommended dietary allowances (25) before the 1953 allowances (26) were published. The average daily intake for all the girls was somewhat below the 1948 recommended

Table 19.—Average daily intake[1] of nine nutrients reported for a seven day period by girls and boys 15 and 16 years of age in three Idaho communities

Group	Number of subjects	Calories	Protein	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Niacin	Ascorbic acid
			gm.	mg.	mg.	I.U.	mg.	mg.	mg.	mg.
Girls										
Boise	46	2136±236	72±8	1105±173	10.5±1.2	6259±188	1.07±.16	2.02±.28	12.5±1.5	66±13
Nampa	54	2101±180	71±7	1060±133	10.8±1.0	5300±193	1.04±.09	1.86±.21	12.5±1.2	73±14
Coeur d'Alene	50	2039±222	71±7	1072±134	10.2±1.1	5086±136	1.04±.10	1.88±.21	11.8±1.1	78±13
N. R. C. 1953 recommended dietary allowances 16 yr.		2400	75	1300	15	5000	1.2	1.9	12	80
Boys										
Boise	44	3035±270	102±8	1515±225	15.9±1.5	7532±224	1.56±.16	2.68±.27	17.1±1.7	78±14
Nampa	40	3022±325	102±12	1544±279	16.6±1.9	6940±135	1.51±.17	2.72±.44	18.5±2.0	81±18
Coeur d'Alene	40	3267±331	108±14	1621±287	16.5±1.8	6557±139	1.70±.20	2.85±.45	17.9±2.2	95±19
N. R. C. 1953 recommended dietary allowances 16 yr.		3800	10[illegible]	1400	15	5000	1.9	2.5	19	100

[1] Average daily intake plus or minus standard error. Standard error based on the variance of average daily differences between subjects; individual daily variation for the same subjects has been ignored.

Figure 7. Distribution of individual average daily intakes of calories and ascorbic acid by sex and community.

allowance for 16-year-old girls in calories, protein, thiamine and ascorbic acid (12, 5, 12 and 10 per cent below, respectively), and was definitely below the recommended allowance in iron (30 per cent below). In the 1953 revision of the recommended dietary allowances (26), the recommended intake of calcium for girls was increased from 1.0 to 1.3 mg. per day. The average daily intake of calcium for the Idaho girls was 1.08 mg.—somewhat higher than the older standard but 17 per cent below the latest recommendation. The average daily intake for all the boys was below the 1948 recommended allowance for 16-year-old boys in calories, thiamine and ascorbic acid (18, 16 and 15 per cent below, respectively). In the 1953 revision of the recommended dietary allowances the recommended intake for 16-year-old boys was increased for thiamine (1.7 to 1.9 mg.) and niacin (17 to 19 mg.). The average intake of the Idaho boys was 16 per cent below the higher level of thiamine and 6 per cent below the higher level of niacin.

Distribution of Individual Intakes

Of greater interest to nutritionists than the average nutrient intake of a group of persons is the number who were eating diets furnishing various levels of the different nutrients. The distributions of the individual average daily intakes of calories and ascorbic acid are shown in Figure 7. The distributions of the intakes of all the nutrients studied, except vitamin A and ascorbic acid, were similar to the distribution of caloric intakes. The difference by sex was pronounced, but there was no marked difference by community. The distribution of vitamin A intakes was similar to the distribution of ascorbic acid intakes. For these two nutrients, there was little difference in the distribution of intakes by sex or by community.

Figure 8 shows the percentage of the boys' and girls' diets which supplied less than the indicated amounts as the average daily intake of the nine nutrients studied. The National Research Council's 1953 recommended dietary allowance and two-thirds of the allowance for 16-year-old boys and girls are indicated for each nutrient, but the cumulative charting permits ready comparison with any standard. The cumulative frequency curves show that for all the nutrients studied the range of intakes was greater for the boys than the girls and that the intakes reported most frequently were higher for the boys than for the girls. These differences by sex were greatest for calories, iron, thiamine and niacin, and were small for vitamin A and ascorbic acid.

Comparison with Recommended Dietary Allowances

The recommended dietary allowances are not to be considered as requirements for the various nutrients, but intakes as low as one-half of the recommended allowances cannot be expected to promote health for most individuals. Intakes below two-thirds of the recommended allowances would not be expected to allow a "margin of safety" to take care of emergency needs, individual

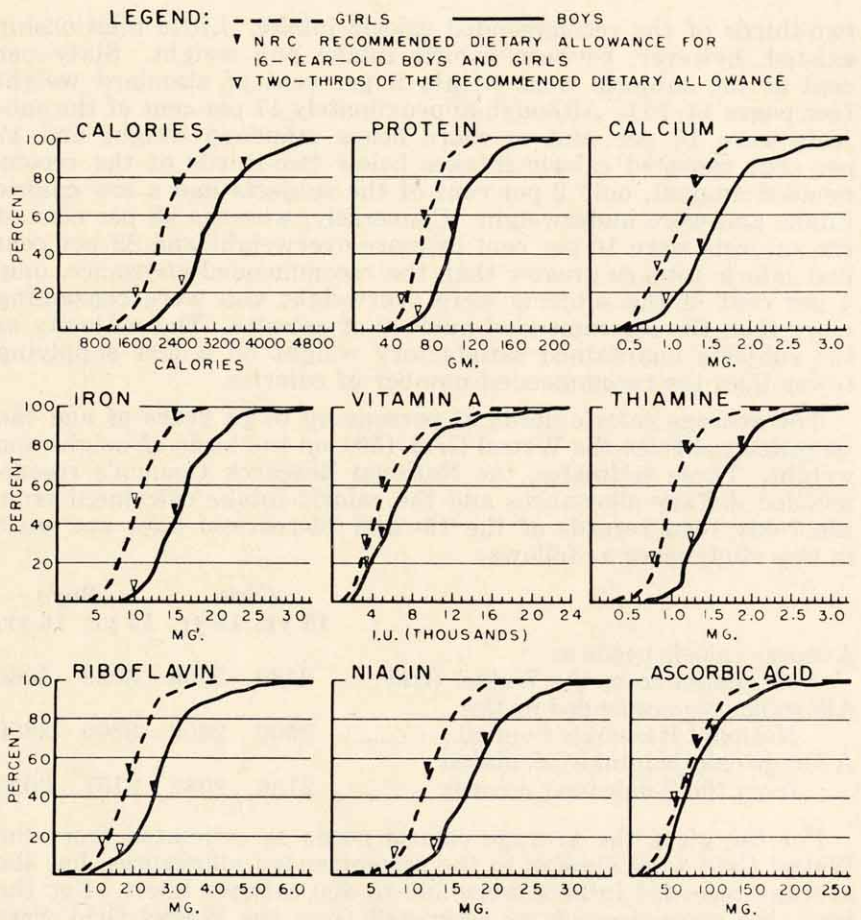

Figure 8. Percentages of subjects with average daily intakes of nine nutrients below the levels indicated.

differences in absorption and utilization, or losses in the preparation or storage of the food.

The average daily intakes for each subject were compared with the National Research Council's 1953 recommended dietary allowances for a person of that age and sex. The intakes of the 50 subjects who were less than 15 years, 6 months of age were compared with the recommendations for children 13 to 15 years of age; the intakes of the older subjects were compared with recommendations for children 16 to 20 years of age.

Caloric Intake

Over 80 per cent of the boys and 70 per cent of the girls reported diets which supplied fewer than the recommended allowance of calories. Approximately 17 per cent of the subjects had less than

two-thirds of the recommended caloric intake. Little relationship existed, however, between caloric intake and weight. Sixty per cent of the subjects were within 9 per cent of standard weight (see pages 14, 15). Although approximately 17 per cent of the subjects were 10 per cent or more below standard weight and 17 per cent reported caloric intakes below two-thirds of the recommended amount, only 2 per cent of the subjects had a low caloric intake and were underweight. Conversely, whereas 23 per cent of the subjects were 10 per cent or more overweight and 22 per cent had caloric intakes greater than the recommended allowance, only 4 per cent of the subjects were overweight and were consuming more than the recommended number of calories. The majority of the subjects maintained satisfactory weight on a diet supplying fewer than the recommended number of calories.

The average caloric needs of persons up to 18 years of age can be estimated from the Wetzel Grid (50) on the basis of height and weight. These estimates, the National Research Council's recommended dietary allowances and the caloric intake calculated from the 7-day food records of the 15- and 16-year-old boys and girls in this study were as follows:

	Girls		Boys	
	15 yr.	16 yr.	15 yr.	16 yr.
Average caloric needs as estimated from the Wetzel Grid	2480	2506	3029	3060
Allowance recommended by the National Research Council	2500	2400	3200	3800
Average caloric intake calculated from the 7-day food records	2106	2087	3157	3093

For the girls, the average caloric needs as estimated from the Wetzel Grid were similar to the recommended allowances, but the average recorded intakes were 300 to 400 calories lower. For the boys, the average needs as estimated from the Wetzel Grid were similar to the average recorded intakes; these values were only a little lower than the allowance recommended for 15-year-old boys but the recommendation for 16-year-old boys was almost one-fourth higher than the average needs as estimated from the Wetzel Grid and the average recorded intake.

The percentage of boys who received fewer than the recommended number of calories was greater than the percentage of boys who received less than the recommended amount of the other nutrients studied. The kind of diet eaten by most of the boys in this study made it possible for them to obtain the needed nutrients with fewer calories than the number recommended by the National Research Council. (This would not necessarily be true for all types of diets eaten by teen-age boys.)

Iron Intake

The average daily intake of iron was less than the recommended allowance for 92 per cent of the girls; 50 per cent of the girls'

iron intakes were below two-thirds of the recommended allowance. Approximately 60 per cent of the boys had iron intakes which met or exceeded the recommended allowance and only one boy had less than two-thirds of the allowance. The recommended allowance of iron for the boys and girls in the age range 13 to 20 years is 15 mg. The diets selected by the majority of the boys furnished this amount, but the girls in general ate less food than the boys and ingested correspondingly less iron.

The biochemical tests made on the blood and serum of these subjects indicate that girls may not require an iron intake as high as that recommended. None of the subjects in this study had hemoglobin values indicative of anemia. The serum iron values for the girls were somewhat, but not significantly, lower than those of the boys (see pages 31, 32). Correlation coefficients were computed between iron intake and hemoglobin and between iron intake and serum iron for the boys and girls. A positive correlation coefficient of 0.33, statistically highly significant, was found between iron intake and hemoglobin values when the data for the boys and girls were combined. This correlation is spurious, however, because it results from the fact that both the iron intakes and the hemoglobin values for the boys were higher than for the girls. When the relationship of iron intake and hemoglobin values was considered for the boys and girls separately, the correlations were insignificant (—0.01 for the boys and —0.03 for the girls). The correlation coefficient between iron intake and serum iron was 0.17 for the boys and 0.25 (highly significant) for the girls. These correlations indicate that the girls may absorb ingested iron more effectively than the boys.

Intakes of iron substantially below the recommended allowances for girls have been reported by a number of workers. The diets of 93 per cent of the girls 16 to 20 years of age studied in Maine, Rhode Island, New York and West Virginia did not meet the recommended allowance of iron and 22 per cent had less than two-thirds of the allowance; the average intake was 10.8 mg. (47). Schlaphoff *et al.* (43), in a study of girls 14 and 15 years of age, found iron intakes as calculated from 3-day food records varying from 6 to 15 mg. Johnson and co-workers (35) reported that 10.4 mg. per day was ample for five women 18 years of age.

Intakes Below One-Half of Recommended Dietary Allowances

Of the 274 subjects in this study, 83 (30 per cent) reported diets which supplied less than one-half of the 1953 recommended dietary allowance of one or more nutrients. Fifty-two subjects reported diets which supplied less than one-half of the recommended intake of only one nutrient, 11 of two nutrients, 10 of three, and 10 of four or more nutrients. The number of subjects who reported diets which supplied less than one-half of the recommended amount of each nutrient was as follows:

Ascorbic acid	49 subjects	Riboflavin	10 subjects
Vitamin A	27	Thiamine	10
Calcium	27	Calories	9
Iron	18	Niacin	6
		Protein	4

Nearly twice as many girls as boys reported these low intakes.

Dietary Supplements

The intakes discussed above include only the food sources of nutrients. Because of the widespread use of dietary supplements, it seemed possible that some of these low dietary intakes would be corrected. Twenty-six subjects reported taking one or more forms of dietary supplements. Only two of these subjects were in the group whose diets supplied less than one-half of the recommended daily intake of some nutrient—both of these subjects had diets low in ascorbic acid but both were taking only yeast as a supplement. Few of the subjects taking supplements were eating diets which supplied less than two-thirds of the recommended intake of the nutrient or nutrients which would be affected by the supplement. The number of subjects taking a supplement which would affect the intake of a given nutrient was as follows, with the number of those subjects whose reported diets supplied less than two-thirds of the recommended daily allowance of that nutrient given in parentheses: calcium, 8 (0); iron, 11 (4); vitamin A, 19 (0); thiamine, 17 (1); riboflavin, 15 (0); niacin, 12 (0); ascorbic acid, 13 (1).

CORRELATIONS

Intakes of the Different Nutrients

Correlation coefficients were calculated for the individual intakes of all pairs of nutrients; highly significant correlations were found for all pairs (Table 20). Particularly high correlations were found

Table 20.—Correlations[1] of individual intakes of nutrients as reported in 7-day food records by boys and girls 15 and 16 years of age in three Idaho communities

Nutrient	Protein	Calcium	Iron	Thiamine	Riboflavin	Niacin	Vit. A	Ascorbic Acid
Calories	.88	.78	.79	.79	.77	.77	.38	.34
Protein		.84	.72	.82	.87	.80	.38	.42
Calcium			.53	.68	.88	.52	.38	.33
Iron				.77	.56	.78	.46	.35
Thiamine					.67	.74	.46	.41
Riboflavin						.63	.51	.45
Niacin							.48	.35
Vitamin A								.37

[1] All correlations significant at the 1% level of probability.

between calories and protein, between calcium and riboflavin, and between protein and riboflavin as would be expected in diets containing liberal amounts of dairy products. The correlation coefficients found between vitamin A and the other nutrients and

between ascorbic acid and the other nutrients were of a lower magnitude than the correlations found among calories, protein, calcium, iron, thiamine, riboflavin and niacin. The correlations of these nutrient intakes indicate that a diet adequate in one nutrient would probably be adequate in the others, but this would be true less often for vitamin A or ascorbic acid than for the other nutrients studied. Special attention should be given to supplying adequate sources of vitamin A and ascorbic acid in the diet.

Nutrient Intake and Blood Serum Levels

Correlations were determined between individual intakes of nutrients and the serum levels of corresponding factors. Statistically significant correlations were found between the dietary intake and the serum level of ascorbic acid (0.52) and between the intake of vitamin A value and serum carotene (0.24), but the correlation between the intake of vitamin A value and serum vitamin A (0.13) was not significant. (The vitamin A value of the diets included carotene, principally from green or yellow vegetables, and vitamin A, principally from milk products and liver.) Riboflavin intake was not significantly correlated with either serum free riboflavin (0.11) or serum total riboflavin (0.14).

NUTRITIVE CONTRIBUTION OF FOOD GROUPS

Each subject's records were tabulated to determine the amount of each food reported as consumed during the 7 days. The average weekly intakes per subject of the different food groups were as follows:

Milk—18.0 cups of milk as a beverage and the equivalent of 3.7 cups of milk from ice cream, cheese, etc.

Cereals—4.1 cups of cereals, 26.8 slices of bread and the equivalent of 7.5 slices from biscuits, pancakes, etc., 6 servings of sweet baked goods and 1.5 cups of popcorn.

Protein foods

Meat—8.3 3-ounce servings.

Legumes and nuts—0.9 cups of legumes and 1.1 ounces of nuts.

Eggs—4.0 eggs.

Citrus fruits and tomatoes—3.4 cups.

Leafy, green and yellow vegetables—3.4 cups.

Other fruits and vegetables

Other fruits—7.5 cups.

Potatoes—4.9 cups.

Other vegetables—1.2 cups.

Sweets—10.1 tablespoons of sugar, jam, etc., 4.2 ounces of candy, 3.6 6-ounce soft drinks and 0.5 cups of desserts such as gelatin.

Fats—4.5 ounces.

The nutrient content of the diets was determined by multiplying the number of portions of each food eaten during the week by

the nutrient content of one portion of that particular food. These data were then summarized by food groups to determine the percentage of the total nutrient intake which had been contributed by each food group. These percentages are shown in Figure 9.

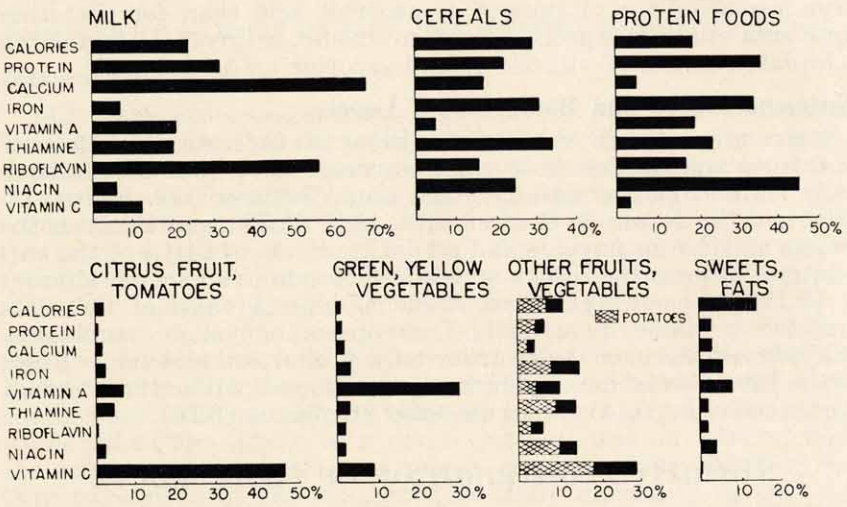

Figure 9. Percentage of total nutrient intake contributed by the different food groups.

Milk products furnished a higher percentage of calcium, riboflavin and protein than any of the other food groups and contributed nearly one-fourth of the calories and one-fifth of the vitamin A and thiamine. More thiamine, iron and calories were furnished by cereals than by any other food group. Cereals also furnished over one-fourth of the niacin and one-fifth of the protein. Meats furnished the largest percentage of niacin and more than one-fourth of the protein and one-fifth of the iron. The protein foods—meats, legumes and nuts, and eggs—together furnished more protein than the milk and more iron than the cereals. The three groups of high-protein foods furnished nearly one-half of the niacin, over one-third of the protein and iron, and approximately one-fifth of the thiamine, calories and vitamin A. The milk, cereals and protein food groups together contributed from 70 to 90 per cent of all the nutrients except vitamin A and ascorbic acid.

Leafy, green and yellow vegetables contributed the largest percentage of vitamin A value. Citrus fruits and tomatoes furnished nearly one-half of the ascorbic acid; potatoes furnished 18 per cent. Although potatoes are commonly thought of only as a high-calorie food, potatoes furnished a higher percentage of ascorbic acid, niacin, thiamine and iron than they did of calories. All the fruits and vegetables together contributed 84 per cent of the ascorbic acid, 47 per cent of the vitamin A value, and approximately 20 per cent of the iron, thiamine and niacin. The fats and

sweets together furnished the same percentage of the calories as did all the fruits and vegetables together, but the fats and sweets contributed little except calories.

The food groups which contributed more than 10 per cent of the total intake of each nutrient and the percentage which that food group contributed were as follows (protein foods include meat, eggs, legumes and nuts; other fruits and vegetables include potatoes):

Calories: cereals, 29; milk, 24; protein foods, 19; other fruits and vegetables, 11.

Protein: protein foods, 36; milk, 32; cereals, 22.

Calcium: milk, 68; cereals, 17.

Iron: protein foods, 34; cereals, 31; other fruits and vegetables, 15.

Vitamin A: green and yellow vegetables, 30; milk, 21; protein foods, 19; other fruits and vegetables, 10.

Thiamine: cereals, 34; protein foods, 23; milk, 20; other fruits and vegetables, 14.

Riboflavin: milk, 56; protein foods, 17; cereals, 16.

Niacin: protein foods, 45; cereals, 25; other fruits and vegetables, 14.

Ascorbic acid: citrus fruit and tomatoes, 47; other fruits and vegetables, 29; milk, 11.

MEAL PATTERNS

For an evaluation of meal patterns, the food records were summarized in terms of food groups included in each meal. This summarization gave the number of times per day or per week that the food groups were eaten rather than the total number of servings of the different food groups. Foods eaten were checked for each day of the week for breakfast, noon meal, evening meal and snack (which included all foods eaten between meals). "Minimum servings" were established for each food group so that small quantities of foods listed on the records—such as one tablespoon of milk added to coffee—would not be considered a serving. The seven food groups used in this part of the study and the amounts of typical foods considered a minimum serving were as follows:

Milk

whole, skim, buttermilk, ⅓ cup; cocoa, milkshakes, ice cream, ½ cup; cheese, 1 ounce.

Cereals

cooked or prepared cereals, macaroni, rice, ⅓ cup; bread, 1 slice.

Protein foods

meat, fish, poultry, 1 ounce; legumes, ½ cup; nuts, 1 ounce; ½ egg.

Citrus fruits or alternate sources of ascorbic acid
oranges, grapefruit, lemons, ½ each; orange or grapefruit juice, 3 ounces; tomatoes, cabbage, broccoli, cauliflower, ½ cup.

Green or yellow vegetables
asparagus, carrots, green beans, greens, peas, pumpkin, squash, sweet potatoes, ¼ cup.

Other fruits or vegetables, ¼ cup.

Sweets
candy, ½ ounce; jam, sugar, sirup, 1 tablespoon; soft drinks, 4 ounces; desserts, sweet baked goods, equivalent of one cookie.

If the minimum amount or more was reported for a particular meal, that food group was checked as having been eaten at that meal. It should be emphasized that the subjects rarely reported only a minimum serving of a food group.

Frequency with Which Food Groups Were Reported

The percentages of the boys and girls who reported eating servings of the food groups the specified numbers of times per week are given in Table 21. Although none of the subjects reported having a serving of one of the food groups the maximum possible number of times (28—three meals and a snack for 7 days), several reported servings of milk, cereals or sweets as often as 26 times a week. The widest spread in reported frequencies was for milk, from 0 to 26 times per week for both the boys and the girls. Eight per cent of both the boys and the girls reported having milk less than seven times a week. On the average, boys reported nearly two more servings per week than the girls of the milk, cereals and protein foods groups; this sex difference in frequency was much smaller for the three groups of fruits and vegetables. The widely held idea that girls eat fruits and vegetables more frequently than the boys was not demonstrated by these subjects.

Table 21.—Percentage of boys and girls reporting a serving of certain food groups the specified numbers of times per week

Number of times per week	Milk		Cereals		Protein foods		Citrus fruit or alternates		Green or yellow vegetables		Other fruits and vegetables		Sweets	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
0	1	1	.....	.....	.....	.....	16	11	4	9	.....	.....	.....	.....
1-2	2	1	.....	.....	.....	1	29	27	23	24	.....	1	.....	.....
3-4	1	3	.....	.....	.....	.....	18	25	30	32	5	6	3	1
5-6	4	3	1	1	2	2	17	15	22	24	8	12	2	2
7-8	4	8	.....	1	2	9	10	15	13	8	20	18	5	6
9-10	4	8	1	6	9	16	7	4	4	3	18	17	10	8
11-12	6	11	5	6	11	23	2	2	3	1	22	18	12	13
13-14	9	15	6	15	27	28	2	.....	.....	.....	13	13	9	21
15-16	17	10	16	20	25	10	.....	.....	.....	.....	9	7	11	15
17-18	14	20	27	27	15	6	.....	1	.....	.....	3	6	24	18
19-20	21	13	23	13	5	5	.....	.....	.....	.....	1	1	8	9
21-22	11	4	15	8	4	1	.....	.....	.....	.....	1	1	8	5
23-24	4	3	3	2	.....	.....	.....	.....	.....	.....	.....	.....	7	2
25-26	3	1	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1
27-28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Average number of times per week													
	16.1	14.2	18.1	16.3	14.5	12.4	3.9	3.9	4.3	3.6	10.4	10.1	15.2	14.4

Over 40 per cent of the subjects reported a serving of ascorbic-acid-rich foods less than three times a week. Thirty per cent of the subjects reported a serving of green or yellow vegetables less than three times a week. Other fruits and vegetables were included in the diets somewhat more often, but inasmuch as this food group included such common foods as potatoes, corn, celery, apples, bananas and peaches, it is surprising to note that 16 per cent of the subjects reported a serving of other fruits or vegetables less than seven times a week.

Figure 10 shows the average number of times per day that servings of the different food groups were reported for each day of the week. No one day had the highest frequency for more than two food groups (Monday was highest for green and yellow vege-

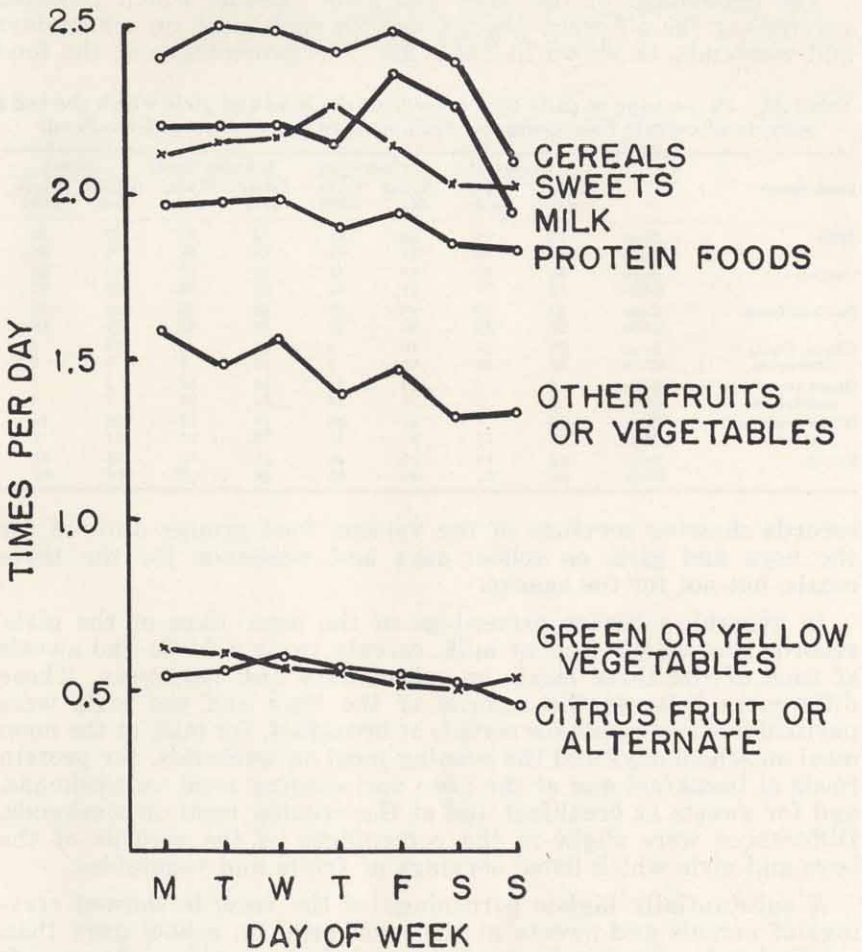

Figure 10. Average number of times per day that servings of certain food groups were reported for each day of the week.

tables and for other fruits and vegetables; Wednesday was highest for protein foods and for citrus fruits or alternate sources of ascorbic acid). Sunday had the lowest frequencies for all but two of the food groups (green and yellow vegetables and other fruits and vegetables); Saturday had the lowest frequencies for these two groups.

Food Groups Eaten at Each Meal

For this phase of the study, the individual food records were classified by sex, by meals and by day of the week rather than grouping the records for each subject. Daily food records were available for 630 school days and 232 weekend days for the boys, 751 school days and 298 weekend days for the girls.

The percentage of the boys' and girls' records which reported servings of the different food groups for each meal, on school days and weekends, is shown in Table 22. The percentages of the food

Table 22.—Percentage of daily food records of the boys and girls which showed a serving of certain food groups at each meal on school days and weekends

Food group		Breakfast		Noon meal		Evening meal		Snack	
		School days	Week-ends	School days	Week-ends	School days	Week-ends	School days	Week-ends
Milk	Boys	77	71	58	49	74	71	27	26
	Girls	70	62	44	51	70	60	25	24
Cereals	Boys	90	90	83	58	65	66	24	21
	Girls	74	77	81	51	58	58	20	27
Protein foods	Boys	43	50	73	67	83	75	10	11
	Girls	28	32	66	57	78	62	11	12
Citrus fruits or alternates	Boys	27	24	10	7	12	10	10	6
	Girls	28	29	11	6	10	5	9	8
Green or yellow vegetables	Boys	1	0	19	26	39	28	2	1
	Girls	0	0	15	24	38	23	2	2
Other fruits or vegetables	Boys	14	7	51	49	79	57	12	14
	Girls	16	17	44	46	73	54	14	19
Sweets	Boys	54	54	62	44	51	56	59	60
	Girls	32	42	64	42	49	46	64	61

records showing servings of the various food groups differed for the boys and girls on school days and weekends for the three meals, but not for the snacks.

In general, a higher percentage of the boys' than of the girls' records showed servings of milk, cereals, protein foods and sweets at each of the three meals on school days and weekends. These differences between the records of the boys and the girls were particularly noticeable for cereals at breakfast, for milk at the noon meal on school days and the evening meal on weekends, for protein foods at breakfast and at the noon and evening meal on weekends, and for sweets at breakfast and at the evening meal on weekends. Differences were slight in the percentages of the records of the boys and girls which listed servings of fruits and vegetables.

A substantially higher percentage of the records showed servings of cereals and sweets at the noon meal on school days than on weekends. Sandwiches and sweet baked goods, candy or soft drinks were commonly included in lunches on school days, but these

foods or others in the cereals or sweets groups were not reported by so many subjects on weekends. A higher percentage of the girls' records showed sweets for breakfast on weekends than on school days. A lower percentage of the records showed servings of green or yellow vegetables and of other fruits or vegetables at the evening meal on weekends than on school days. A lower percentage of the girls' records showed servings of milk and protein foods at the evening meal on weekends than on school days.

A consistently lower percentage of the records reported servings of the food groups for weekends than for school days. In those instances when a food group was reported more frequently for one meal during the weekends than for school days the increase was more than offset by the decrease in frequency at another meal.

Combinations of Food Groups Eaten at Each Meal

Table 23 gives the percentages of the daily food records which reported servings of different combinations of food groups for the three meals on school days and weekends. Snacks are not included in the table because only small differences were found in the records of the boys and girls on school days and weekends. In order to simplify the presentation, the food group "sweets" is not included in this table, and all combinations of the groups of fruits and vegetables are listed together. Each figure on the table represents the percentage of the records for that sex, meal and part of the week which reported a serving of the food groups listed both vertically and horizontally for that space on the table. For example, in the "Milk" row, the first column, "None," shows the percentage of the records which reported milk and no other food group for that meal; the second column, "Cereals," shows the percentage of the records which reported a meal of milk and cereal, etc.

The most popular pattern for breakfasts during the entire week for the girls was milk and cereals. This combination was also the most popular for the boys on school days, with the combination of milk, protein foods and cereals a close second; these two combinations reversed rank of popularity for the boys on weekends. The combination of milk, protein foods and cereals was second for the girls on weekends. A combination of milk, cereals and citrus fruit was the second most popular combination for the girls on school days.

For the noon meal on school days the combination of milk, protein foods, cereals and other fruits or vegetables was the most popular with the boys and ranked second for the girls. The combination reported on the highest percentage of the girls' records for the noon meal on school days was protein foods and cereals; this combination ranked third for the boys. The combination of milk, protein foods and cereals ranked second for the boys and third for the girls. For the noon meal on weekends, the only pattern reported on more than 10 per cent of the records for both boys and girls was no serving of these food groups.

Table 23.—Percentages of daily food records showing servings of combinations of food groups[1] at each meal on school days and weekends

Breakfast

Food groups		None	Cereals	Cereals+other fruits or vegetables	Cereals+citrus fruits or alternates	Cereals+green or yellow vegetables	Cereals+2 or 3 types of fruits or vegetables	Other fruits or vegetables	Citrus fruits or alternates	Green or yellow vegetables	2 or 3 types of fruits or vegetables
School days											
Boys	None	4	5	1	2	0	*	*	0	0	0
	Milk	2	22	6	13	0	*	0	0	*	0
	Milk+protein foods	1	20	3	8	0	1	*	0	0	*
	Protein foods	1	5	1	2	0	0	0	0	0	0
Girls	None	10	5	1	4	0	0	1	2	0	0
	Milk	7	22	8	11	0	*	2	1	0	0
	Milk+protein foods	1	9	2	6	0	*	*	1	0	0
	Protein foods	1	3	1	2	0	*	*	1	0	0
Weekends											
Boys	None	5	5	1	1	0	*	*	*	0	0
	Milk	2	20	4	10	0	0	0	0	0	0
	Milk+protein foods	1	21	5	8	0	1	*	0	0	0
	Protein foods	*	10	1	3	0	0	0	0	0	0
Girls	None	9	8	1	5	0	*	1	4	0	0
	Milk	2	20	5	8	0	1	1	2	0	0
	Milk+protein foods	*	12	3	5	0	1	1	1	0	0
	Protein foods	1	3	2	2	0	1	1	0	0	0

Noon meal

Food groups		None	Cereals	Cereals+other fruits or vegetables	Cereals+citrus fruits or alternates	Cereals+green or yellow vegetables	Cereals+2 or 3 types of fruits or vegetables	Other fruits or vegetables	Citrus fruits or alternates	Green or yellow vegetables	2 or 3 types of fruits or vegetables
School days											
Boys	None	7	2	2	1	0	1	1	0	0	0
	Milk	1	4	5	*	*	2	1	0	0	0
	Milk+protein foods	1	12	13	1	3	10	2	*	*	1
	Protein foods	*	11	10	2	2	2	*	*	*	1
Girls	None	8	3	2	*	*	*	3	*	0	*
	Milk	2	5	4	1	*	2	2	0	0	*
	Milk+protein foods	*	10	8	1	1	5	1	*	*	2
	Protein foods	*	17	12	2	1	4	*	*	*	1
Weekends											
Boys	None	20	1	1	0	0	0	*	*	0	*
	Milk	1	3	3	0	0	1	*	0	0	0
	Milk+protein foods	1	9	9	0	1	8	4	0	1	8
	Protein foods	2	8	6	*	2	5	1	0	0	3
Girls	None	22	1	1	0	*	0	1	1	0	1
	Milk	2	4	6	0	1	*	2	0	0	1
	Milk+protein foods	2	8	6	1	1	6	2	0	*	8
	Protein foods	1	6	2	*	2	4	4	*	*	2

Evening meal

Food groups		None	Cereals	Cereals+other fruits or vegetables	Cereals+citrus fruits or alternates	Cereals+green or yellow vegetables	Cereals+2 or 3 types of fruits or vegetables	Other fruits or vegetables	Citrus fruits or alternates	Green or yellow vegetables	2 or 3 types of fruits or vegetables
School days											
Boys	None	2	1	2	0	*	1	1	0	0	0
	Milk	*	1	4	*	*	2	1	*	0	1
	Milk+protein foods	1	5	18	1	3	14	8	*	1	13
	Protein foods	*	2	5	*	1	4	2	0	*	4
Girls	None	2	*	1	0	*	1	*	*	*	1
	Milk	1	3	3	0	1	3	2	0	*	2
	Milk+protein foods	1	7	12	1	2	10	9	*	1	11
	Protein foods	*	3	6	1	1	3	4	*	*	6
Weekends											
Boys	None	8	1	*	0	0	*	0	1	0	0
	Milk	1	4	3	1	*	1	2	0	0	1
	Milk+protein foods	1	14	13	0	3	11	5	0	2	9
	Protein foods	0	5	7	*	0	2	1	0	0	3
Girls	None	13	1	3	0	0	1	1	0	0	0
	Milk	4	5	4	0	*	2	1	0	1	2
	Milk+protein foods	*	10	10	*	1	5	5	0	2	7
	Protein foods	2	5	7	0	1	3	3	0	0	2

[1] Combination of food groups reported includes groups listed in the horizontal row plus those in the vertical column.
* Less than 1 per cent of the records.

For the evening meal on school days, the combination of milk, protein foods, cereals and other fruits or vegetables was the most popular with both boys and girls. The combination of milk, protein foods, cereals and two or three types of fruits or vegetables was second for the boys and third for the girls. This combination minus cereals was the second for the girls and the third for the boys. For the evening meal on weekends for the boys, the most popular combination of food groups was milk, protein foods and cereals; this combination plus other fruits or vegetables ranked second, and the same combination plus two or three types of fruits or vegetables ranked third. The only pattern reported on more than 10 per cent of the girls' records for the evening meal on weekends was no serving of these food groups.

The meal patterns chosen most frequently by the boys and girls give considerable information about the food habits of the group, but patterns reported by only a few subjects are also of interest. For example, for all the meals for boys and girls on school days and weekends there were some records which showed a serving of the milk group and nothing else, some which showed only a cereal and others only a fruit or vegetable.

From Table 23 one can determine the percentages of the records which reported meals which would conform to any given standard in terms of these food groups. For example, breakfasts should include at least a serving of milk, cereal and fruit if it is to contribute one-fourth of the day's nutritive requirements. By adding the figures in the appropriate sections of Table 23, it is found that only 31 per cent of the boys' records and 28 per cent of the girls' records on school days and 27 per cent of the boys' records and 23 per cent of the girls' records on weekends reported breakfasts which included at least milk, cereal and fruit.

A combination of milk, cereal, protein food and fruit or vegetable would be a pattern for the noon and evening meals which would probably furnish a fairly adequate supply of the essential nutrients. Only 27 per cent of the boys' records and 15 per cent of the girls' records for school days and 18 per cent of the boys' records and 14 per cent of the girls' records for weekends reported servings of all four of these food groups at the noon meal. For the evening meal, these four food groups were reported in 36 per cent of the boys' records and 25 per cent of the girls' records for school days and for 27 per cent of the boys' records and 16 per cent of the girls' records for weekends. The adequacy of a diet, of course, cannot be determined by how well single meals fit an arbitrary pattern, but this type of comparison does show ways in which the diets could be improved. For example, only 15 per cent of the girls' records listed milk, cereal, protein food and fruit or vegetable for the noon meal on school days. However, 61 per cent of these records listed cereal, protein food and fruit or vegetable. The subjects who were getting at least a cup of milk at the other two meals may not have needed milk at the noon meal, but because so many of these girls did not drink milk at noon it

would be wise for homemakers and school lunch planners to include other forms of milk frequently in lunches—cheese, white sauce, cream soup, milk desserts, etc.

The percentages of the records which listed no servings of fruits or vegetables were even higher than might be assumed from Table 22. For example, the percentages of the boys' records for noon meals on school days which listed a serving of ascorbic-acid-rich fruit or vegetable, green or yellow vegetable, or other fruit or vegetable were 10, 19 and 51, respectively. It might be assumed that these percentages would be additive, so that 80 per cent of these records listed a serving of some fruit or vegetable. Table 23 shows, however, that only 60 per cent of these records did list a fruit or vegetable. The percentages of the records for each meal which listed no servings of fruit or vegetables were as follows:

	Breakfast		Noon meal		Evening meal	
	School days	Week-end	School days	Week-end	School days	Week-end
Boys	60	64	38	45	12	34
Girls	58	55	45	46	16	40

Snacks

The pattern of snacks was similar for the boys and girls on school days and weekends. Approximately one-fourth of the records showed no snacks and one-fourth reported snacks consisting only of sweets. Nine per cent of the records listed snacks of milk and sweets; 4 per cent listed snacks of cereals and another 4 per cent listed snacks of sweets and other fruits or vegetables. On the remaining records, snacks consisting of all possible combinations of food groups (except the combination of milk, protein foods and green or yellow vegetables) where reported.

Meals Omitted

The frequency with which the subjects reported eating nothing for a particular meal varied with the part of the week and with sex, as is shown in Figure 11. For breakfast, there was a greater difference between sexes than between school days and weekends in the percentage of records listing no food. A small difference between sexes was found for the percentage of noon meals omitted, but there was a striking increase in the percentage of records showing no food for noon meals on weekend days over the corresponding percentage for school days for both boys and girls. Nearly one-fifth of the records for weekends showed no noon meal. Only 2 per cent of the records showed no evening meal on school days, but the percentage which listed no evening meal increased for weekends, and increased more for the girls than the boys. An increase in the percentage of the records listing a snack on weekend days would be expected, to compensate for the number of noon and evening meals omitted, but this was not found. In fact, the percentage of the boys' records which listed no snack was somewhat greater on the weekends than on school days.

A pattern for Sunday meals of a late breakfast and the noon and evening meals combined as one main meal would explain the increase in the percentage of meals omitted during weekends and the decrease in frequency of reported servings of the different food groups during the weekends. However, inspection of the food records showed that this pattern was rarely followed. Most of the subjects who reported a "Sunday dinner" reported a light third meal as well. Many of the subjects reported no Sunday meal which could be considered a "Sunday dinner," presumably either because the housewives took a holiday from cooking on Sundays and the families helped themselves to whatever was readily available, or because the subjects were too busy with their own activities to join their families for the main meal. In general, the subjects reported breakfasts on Sundays which were as large or larger than those reported for the rest of the week, but many reported only sandwiches, milkshakes, soft drinks, etc. for the other Sunday meals. Saturday meals were also likely to be sketchy; over 40 per cent of the noon meals omitted on weekends were on Saturdays.

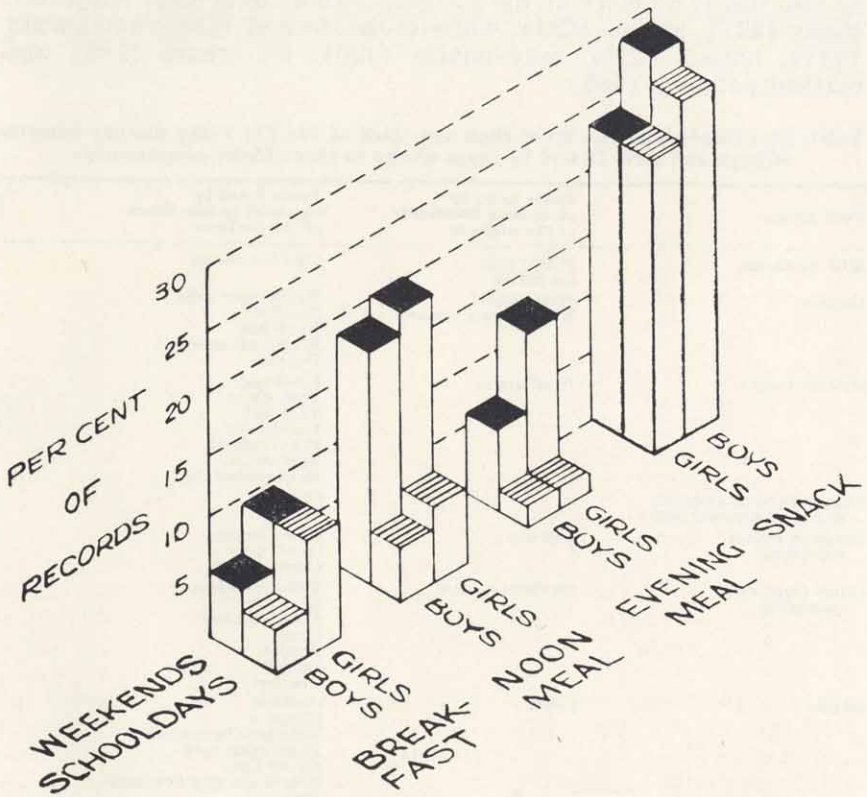

Figure 11. Percentage of the food records of the boys and girls which listed no food for breakfast, noon meal, evening meal or snack on school days and weekends.

The food records in this study were made during a 5-month period, so the poorer diets observed for weekends were not the results of some factor (such as a basketball tournament) which might have affected the diets of a large number of students on one weekend.

FOODS MOST COMMONLY REPORTED

A total of 467 individual foods were reported on the food records kept by the 274 subjects. This number includes the various ways of preparing a food, e.g. mashed potatoes, boiled potatoes, baked potatoes and French fried potatoes were considered separate foods. Different units of measurement for a single food were used for convenience in tabulating the food records (milk was tabulated and coded by the tablespoon, cup and quart), but these were not included in the count of individual foods. Only 46 foods were reported by more than one-third of the subjects. These foods are listed in Table 24. White bread was included in the records of the largest number of the subjects (260). Only nine other foods were reported by two-thirds or more of the subjects: whole milk (257 subjects), sugar (237), lettuce (221), white bread toasted (218), hamburger (211), butter (190), mayonnaise (190), ice cream (185) and mashed potatoes (185).

Table 24.—Foods listed on more than one-third of the 274 7-day dietary records of boys and girls 15 and 16 years of age in three Idaho communities

Food group	Foods listed by more than two-thirds of the subjects	Foods listed by one-third to two-thirds of the subjects
Milk products	Whole milk Ice cream	Cheddar cheese
Cereals	White bread White bread, toasted	Hamburger buns Crackers Pancakes Whole wheat bread Popcorn
Protein foods	Hamburger	Fried eggs Pork chops Tuna fish Lunchmeat Frankfurters Beef chuck Hard cooked eggs
Citrus fruits or alternate source of ascorbic acid		Oranges Catsup
Green or yellow vegetables	Lettuce	Green beans Green peas Carrots, raw
Other fruits or vegetables	Mashed potatoes	Boiled potatoes Bananas Fried potatoes Corn Apples Celery Peaches
Sweets	Sugar	Cookies Sirup Kola type beverages Plain cake, iced Candy bars Ginger ale type beverages Jam
Fats	Butter Mayonnaise	Bacon Margarine
Accessories		Gravy

DISCUSSION

After a number of diet history interviews, the nutritionists stated that a subject's general appearance—enthusiasm, interest, vitality —usually corresponded closely with the type of diet the subject customarily had. These observations were too intangible and subjective to be used as a measure of nutritional status, but nevertheless were sometimes more illuminating than the objective physical examination. For example, the physical examination of subject 010 was essentially normal except for a mild dermatitis and pharyngitis, but the nutritionist had added this comment to the diet history form: "The gym teacher says this girl lacks pep and tires easily." Her food records showed that she skipped at least one meal each day or had only milk for one or two meals. Her entire recorded food intake for one school day was 1 cup of milk and 1 slice of buttered toast for breakfast; 1½ cups of milk for lunch; no evening meal; and a soft drink and a candy bar for a snack. This was the smallest food intake she recorded, but her diet on the school day she recorded the largest intake could do little toward making up the deficiencies of the other days—2 cups of milk for breakfast; toasted cheese sandwich for lunch; peas, fried potatoes, bacon and cookies for the evening meal; an ice cream sandwich, ½ candy bar, a soft drink and 4 cups of milk for snacks.

The records of this subject (010) illustrate the result of placing too much emphasis on the importance of a single food. This subject drank plenty of milk, averaging well over a quart a day, but her intake of the other food groups was low—7 servings of cereals, 5 of protein foods, 8 of vegetables and 1 of fruit during the week. Nutritionists consider milk as an important, practically as an essential, part of the diet, but milk alone should not be expected to provide all the nutrients needed. Because of the ample milk intake, the diet of this subject furnished the recommended dietary allowance of calcium and riboflavin and over 80 per cent of the allowance of protein, but the diet supplied less than two-thirds of the recommended allowance of calories, vitamin A, thiamine and niacin, and less than one-half of the allowance of iron and ascorbic acid.

A problem affecting the diets of these school children resulted from the custom of serving the main meal at noon and only a light meal, frequently of left-overs, in the evening. For children who did not eat the noon meal at home or who did not have a good meal at school, this practice frequently resulted in poor diets. Here are three evening meals recorded by one subject:

2½ cups boiled navy beans, 3 slices white bread with 3 teaspoons butter, 2 cups coffee with 3 teaspoons sugar.

6 slices white bread, 6 teaspoons butter, 3 slices minced ham, ¾ cup baked beans, 2 cups milk.

2 boiled potatoes, 1 slice white bread, 1 teaspoon butter, 1 cup milk.

If an evening meal such as one of these followed a lunch of one of the combinations so popular with these teen-age subjects—French

fried potatoes and catsup, a soft drink and doughnut, or even the more nutritious hamburger and milkshake combination—the children would not receive enough of the food elements essential for growth, health and vitality during adolescence and the years ahead.

Economics was not the important factor in most of the poor diets in this study; in two of the communities a well balanced lunch was available at the school cafeteria costing the same or less than the students paid for the hamburger and soft drink type of lunch they selected at the restaurants.

The school lunch made important contributions to the diet of many of the subjects. The only servings of citrus fruits or green or yellow vegetables which some subjects reported during the week were those served at the school cafeteria. The importance of the school lunch was strikingly illustrated by the food records of subject 150, a 16-year-old farm boy from Nampa. During the five school days on which he recorded his food intake, he ate four lunches at the school cafeteria, one lunch, one supper and one snack at a restaurant, and five breakfasts, three suppers and one snack at home (one supper was omitted). The total amount of food reported for the five school days was as follows:

Food group	At home or restaurant (10 meals and 2 snacks)	At school cafeteria (4 meals)
Milk	5 c. milk 2 milkshakes	4 c. milk 1 c. milk gravy
Cereals	15 slices bread 2 buns 7 doughnuts	12 slices bread 1 bun 1 piece cake
Protein foods	3 hamburger patties 3 slices minced ham 3 eggs ¾ c. baked beans	1 hamburger pattie 1 slice meat loaf 1 slice chicken loaf 1 slice ham
Citrus fruits		1 c. orange-grapefruit juice
Green or yellow vegetables		1 med. raw carrot 9 leaves lettuce ½ c. green beans ½ c. peas
Other fruits and vegetables	4 med. potatoes	1 med. potato 1 c. mixed vegetables 1 c. applesauce ¾ c. peaches ½ c. cherries ½ c. plums
Fats	7 tsp. butter	7 tsp. butter
Sweets	14 tsp. sugar 2 popcicles	
Other	2½ c. popcorn 9 c. coffee	

The foods recorded by this subject furnished two-thirds or more of the recommended allowances of all the nutrients except calories, thiamine and ascorbic acid. But how would his nutrient intake have compared with the recommendations if he had lunched on doughnuts and coffee instead of eating at the school cafeteria?

Another problem which concerned the nutritionists in this study was the interpretation which some of the student athletes put on the coach's training rules, particularly regarding eating before games. Subject 145 wrote on his last food record, "If you wonder why I eat so little some days, it is because I play basketball and we players are not allowed to eat much before a game." On that food record this subject had recorded a good breakfast (½ grapefruit, 1 cup of shredded wheat, 2 cups of milk, 1 slice of toast, 1 cup of cocoa, 2 pancakes, 3 teaspoons of sugar and 1 teaspoon of butter) but he had only a piece of cherry pie for lunch and 2 cups of peaches and a piece of cake for the evening meal. His lunches on three school days consisted of a hamburger and soft drink, with or without French fried potatoes, pie or candy bar, and on two days was only a piece of pie. Three of his suppers consisted principally of canned peaches. In emphasizing that the players should not eat a heavy meal before a game, the coach had evidently not stressed the importance of lunches adequate to make up for the reduced food intake. Large breakfasts alone cannot supply the energy value and the nutrients needed to supply the demands of growth and strenuous activity for the student athletes over a period of several months.

The food records of subjects whose teeth were severely affected by decay were studied with interest. One of the subjects with complete upper dentures had a total milk intake for the week of only 4 cups, and a high consumption of sweets—14 candy bars, 4 soft drinks, 11 tablespoons of sugar, cake or cookies 9 times. In other respects this subject's diet was better than average for the Idaho subjects—12 servings of cereals, 16 of protein foods, 15 of vegetables and 14 of fruits. A subject who had a filling or cavity in every tooth had no milk (except 2 ice cream bars) but had 26 cups of tea with sugar and 6½ soft drinks instead. Except for the 13 tablespoons of sugar in the tea, this subject's consumption of sweets was fairly low (2 ounces of candy, 8 desserts) but so was his consumption of other foods—13 servings of cereals, 9 of protein foods, 13 of vegetables and only 1 of fruit. The diets of these two subjects seem to show a connection between poor diet and poor teeth, but the diet of a third subject shows that the problem is not that simple. This subject had 16 cups of milk and 3 milkshakes, an intake of sweets well below average (4 desserts, 3 tablespoons of chocolate sirup, 2 soft drinks), and 12 servings of cereals, 15 of protein foods, 14 of vegetables and 7 of fruits. The diet reported for that week would give no indication of why this 16-year-old girl should have upper dentures.

At the opposite extreme were subjects whose teeth were in excellent condition but whose diets seemed to violate all rules of good nutrition. A striking example was a Nampa boy whose teeth were in perfect condition except for one small filling, but whose diet on a typical school day was as follows: breakfast—7 biscuits with jelly and margarine, 2 cups of coffee with sugar; lunch—hamburger, catsup, French fried potatoes, soft drink; evening meal

—hot dog, French fried potatoes, catsup, soft drink, 2 candy bars, pie. Actually, this subject ate large enough quantities of food so that his intake of nutrients was within two-thirds of the recommended dietary allowances except for thiamine and ascorbic acid (62 and 34 per cent of the allowances, respectively). Furthermore, this farm boy had only been eating this way for several months, since he had gotten a part-time job which supplied spending money and kept him in town in the evenings.

The types of lunches and snacks eaten by the subjects in this study indicated that most of them had a liberal amount of spending money. Emphasis should be placed on teaching school children to get their money's worth nutritionally in the foods they choose. This problem, especially for snacks, is complicated by the fact that nutritious snacks such as milk or fruit are usually more expensive, less readily available and less glamorized by advertising than are other snacks which nutritionally furnish little besides calories and which tend to promote tooth decay.

Omitting a meal or having only a candy bar or only a piece of pie for a meal occasionally would have no serious effects. For many of these subjects, however, such meal patterns did not occur only occasionally. Neither these teen-age students nor their parents had been made sufficiently aware of the importance of regular, balanced meals.

General Discussion

In this study of teen-age school children in northern and southwestern Idaho, the only outstanding difference by area was in the condition of the teeth. The boys and girls reared in the Coeur d'Alene area had an average of more than twice as many teeth decayed, filled or extracted because of decay than did the children reared in the Nampa and Boise areas. Practically no difference by area was observed for heights, weights, relative growth advancement or retardation, history of diseases or values for the biochemical blood factors studied.

The 7-day food records kept by these subjects did not show any definite differences by area in average intake of the nutrients studied or in food habits. However, the food values used to calculate the nutrient content of the diets in this study were only average "book" values and not the values obtained by actual assay of the foods eaten. Analysis of the foods eaten in each area might show differences in the nutritive content of the diets. Nutrients other than those studied may be of importance in the formation and maintenance of good teeth. There may be differences by area in the food habits and nutrient intake of children younger than the subjects in this study.

The difference in the fluoride content of the water supplies used in each area would explain some but not all of the difference in the susceptibility to decay of the teeth of persons reared in these

areas. A number of trace elements in addition to fluorine—e.g. vanadium, copper and manganese—have been reported to reduce dental caries in experimental animals. The effect on tooth decay of trace elements and of minerals such as calcium in the water should receive more study. A mineral such as calcium might not be utilized directly by the body, but the calcium content of the water might affect the amount of calcium which would be lost in cooking certain foods. Thus a given combination of foods might supply adequate minerals when prepared under one set of conditions and yet supply only minimal amounts if prepared under a different set of conditions.

Actual dietary deficiencies probably played little part in determining the tooth condition of the subjects in this study (except for the lack of fluorides and possibly of minerals in the water in the northern part of the state). Too much rather than too little would more often have been the problem—too many sweets, highly refined cereals and soft drinks which are known to favor tooth decay, particularly when these foods are eaten at the expense of foods which are a better source of vitamins and minerals. In their food records, the Idaho subjects reported an average intake of more than 4 candy bars, 10 tablespoons of sugar, jam, etc., 6.5 servings of desserts and sweet baked goods and nearly 4 soft drinks per week. The subjects in the Coeur d'Alene area did not consume more sweets than the subjects in the southwestern area, but in areas where environmental conditions do not favor the formation of sound teeth, dietary habits which promote dental health are particularly important.

Summary and Conclusions

School children 15 and 16 years of age reared in the Boise, Nampa and Coeur d'Alene areas were studied with dental and physical examinations, biochemical blood tests and dietary records. The southwestern and northern sections of Idaho were chosen for study because earlier work had shown that the teeth of persons reared in these sections differed in degree of susceptibility to decay. The study communities in these sections were chosen on the basis of population, local health facilities and organization, and the fluoride content of the municipal water supplies (Boise 0.5 p.p.m., Nampa 1.5 p.p.m., Coeur d'Alene 0.0 p.p.m.).

Dental Examinations

Dental examinations including posterior bite-wing X-rays are reported for the 215 subjects who had not been away from the study communities more than 2 months in any year.

The subjects who were continuous urban residents of Nampa averaged 5.7 decayed, missing or filled (D.M.F.) teeth including X-ray findings, and the corresponding group of Boise subjects averaged 7.5 D.M.F. teeth. This difference, however, was not statistically significant. The average number of D.M.F. teeth for

the Coeur d'Alene group, 18.2, was more than twice that of the Boise and Nampa groups. In addition to the lack of fluorides in the water, other factors which may be involved in the severe dental health problem in the northern part of Idaho are climatic conditions and the lack of minerals in the water and soil.

Nearly one-half of the total number of carious teeth for each group of subjects were found by X-ray. However, the relative differences between the average numbers of D.M.F. teeth for the subjects in the three communities were practically unchanged by the inclusion or omission of X-ray findings.

Physical Examinations

The incidence of the "childhood" diseases, operations and broken bones reported in the medical histories was similar for the subjects in each community.

There was practically no difference by community in mean heights or weights for the boys and girls. The boys averaged nearly 4 inches taller and 16 pounds heavier than the girls. The Idaho boys averaged approximately one-half inch taller and over 4 pounds heavier than the Baldwin-Wood standard. The Idaho girls averaged somewhat shorter but about 3 pounds heavier than the Baldwin-Wood standard.

The height-weight-age data were plotted on the Wetzel Grid. More than one-half of the subjects fell in the center channels which denote medium build. More girls than boys were in the channels denoting stocky or obese build; more boys than girls were in the channels denoting slender build. The relative advancement or retardation of each subject was determined in relation to the developmental level reached by 67 per cent of the general population of healthy children of the same age. Nearly one-half of the boys but only one-sixth of the girls had a developmental age within a year of the chronological age. One-half of the girls had a developmental age from 1 to 3 years greater than the chronological age.

Skeletal age was estimated from X-ray films of the hands. The skeletal age was greater than the chronological age for most of the girls, but the skeletal age was less than the chronological age for most of the boys.

In the medical examinations, acne was the condition most commonly observed. Conditions associated with the common "cold" were observed frequently, with the Boise subjects having the highest incidence. Tonsillitis and enlarged lymph nodes were observed frequently in the Coeur d'Alene area. In general, the subjects were in good physical condition and few signs which could definitely be associated with poor nutrition were observed.

The sedimentation rate of the blood was above normal for over one-fifth of the subjects. Nearly three-fourths of these subjects were observed to have colds, tonsillitis or similar infections. Thirty-eight per cent of the subjects with high sedimentation rates were

10 per cent or more above standard weight; for 19 per cent of the subjects with high sedimentation rates, overweight was the only abnormal finding in the physical examination.

None of the subjects had hemoglobin values indicative of anemia.

Biochemical Tests

Thirteen biochemical determinations were made on blood samples of fasting subjects.

Statistically significant differences were found between the mean values of the boys and girls for serum ascorbic acid, serum free cholesterol, serum alkaline phosphatase, serum copper, hemoglobin, sedimentation rate and volume of packed cells. Subjects 15 years of age had serum alkaline phosphatase values significantly higher than the older children. The subjects in the northern community had mean serum carotene and mean serum copper values significantly lower than the subjects in the two southwestern communities.

Few of the values for the biochemical constituents studied were outside the criteria which have been suggested as normal by other workers.

Highly significant positive correlations were found for both boys and girls between the following comparisons of blood constituents: vitamin A and carotene; vitamin A and both free and total cholesterol; carotene and ascorbic acid; carotene and both free and total cholesterol; free and total riboflavin; free and total cholesterol; copper and sedimentation rate; hemoglobin and packed cell volume. In many of the other comparisons between blood constituents, only the data of the boys showed highly significant correlations. Further work is needed to explain these sex differences.

Dietary Studies

Diet Histories:

A nutritionist interviewed each subject to obtain information about production and preservation of food by his family for home use, food likes and dislikes, and customary eating patterns.

More families in Nampa and Coeur d'Alene than in Boise produced vegetables, fruit and meat for home use. Nearly all families preserved some fruits by canning and approximately three-fourths canned some vegetables. In each area, more subjects reported that their families froze meats than froze fruits or vegetables.

The food named most often as a favorite food was potatoes. Asparagus and liver were mentioned most frequently as being disliked. Except for potatoes, vegetables were mentioned more often as being disliked than liked. Fruits were usually liked. Meats, except liver, were mentioned more often as being liked than as being disliked. All forms of sweets were mentioned only 44 times as favorite foods, but fruits and vegetables were mentioned as favorite foods 161 times and meats 101 times.

The subjects estimated that they ate specific foods more frequently and in larger amounts than was shown by the food records. For some foods, such as eggs, the difference was small, but for other foods, such as milk and green or yellow vegetables, the difference was large.

The diets were appraised by the nutritionists following the interviews. More than one-half of the diets were appraised as furnishing less than 80 per cent of the recommended dietary allowances of thiamine, ascorbic acid and iron.

Nutrient Intake:

As calculated from the 7-day records of measured food intake, the average intake per subject of the nine nutrients studied showed little variation by community, but a pronounced difference by sex in each community. Males consumed substantially more than the females of all nutrients.

The average intakes per subject exceeded 90 per cent of the National Research Council's 1953 recommended dietary allowances except for iron, calcium, calories and thiamine for the girls and calories, thiamine and ascorbic acid for the boys. Few of the girls met the recommended allowance of iron.

Three-fourths of the subjects reported diets which did not supply the recommended number of calories, but the deviation from standard weight was not related to caloric intake. The percentage of the boys who received less than the recommended caloric intake was greater than the percentage who received less than the recommended amounts of the other nutrients studied.

Thirty per cent of the subjects reported diets which supplied less than one-half of the recommended allowance of one or more nutrients most often ascorbic acid, calcium or vitamin A. None of these subjects was taking a dietary supplement which would affect the nutrient or nutrients in which his diet was low.

The correlations between the dietary intake of ascorbic acid and serum ascorbic acid and between dietary vitamin A and serum carotene were statistically significant. No significant correlation was found between dietary vitamin A and serum vitamin A or between dietary riboflavin and serum riboflavin. Dietary iron intake and serum iron were significantly correlated for the girls but not for the boys. Dietary iron was not significantly correlated with hemoglobin values when the data of the boys and girls were considered separately.

Nutrient Contribution of Food Groups

The percentage of the total nutrient intake which was contributed by each group of foods was determined. The milk group furnished a higher percentage of calcium and riboflavin than any other food group and contributed nearly one-third of the protein and one-fourth of the calories. Cereals furnished more thiamine

and calories than any other food group and contributed nearly one-third of the iron and over one fourth of the protein. The protein foods—meats, legumes and nuts, and eggs—furnished more niacin, protein and iron than any of the other groups, and approximately one-fifth of the thiamine, calories and vitamin A. Milk, cereals and protein foods together furnished over 70 per cent of all nutrients except vitamin A and ascorbic acid. Fruits and vegetables contributed 84 per cent of the ascorbic acid, 47 per cent of the vitamin A and approximately one-fifth of the iron, thiamine and niacin.

Meal Patterns

The 7-day food records were analyzed and evaluated in terms of the food groups reported for each meal on school days and weekends.

Milk, cereals and protein foods were reported more frequently by the boys than by the girls, but the sex difference in frequency was much smaller for the fruits and vegetables.

Approximately 14 per cent of the subjects reported no servings of citrus fruits or alternate sources of ascorbic acid and more than 40 per cent reported servings of ascorbic-acid-rich foods less than three times per week. Thirty per cent of the subjects reported servings of green and yellow vegetables less than three times per week.

The percentages of the food records showing servings of the various food groups differed for the boys and girls on school days and on weekends for breakfast, noon meal and evening meal, but not for snacks. The percentages of daily food records which reported a serving of a food in the different food groups was consistently lower on weekends than on school days. More meals were missed during weekends than on school days; nearly one-fifth of the weekend records showed no noon meal. Many subjects had only sketchy noon and evening meals on Sundays and Saturdays. The number of snacks eaten during weekends did not increase to compensate for the smaller amount of food eaten at weekend meals.

The combinations of food groups eaten at each meal by the boys and girls on school days and weekends are reported.

Foods Most Commonly Reported

Only 46 foods were listed on the records of more than one-third of the subjects and only 10 of these were reported by more than two-thirds of the subjects. White bread, whole milk, sugar, lettuce, white bread toasted and hamburger were the most commonly reported foods.

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