AN EXTENSION AND EVALUATION OF A NUTRITIONAL SURVEY OF CERTAIN HIGH SCHOOL STUDENTS IN HOLLAND, MICHIGAN.

by

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INTRODUCTION

Nutrition workers have long been confronted with the problem of finding more adequate yet practical methods of appraising the nutritional status of individuals and of population groups (24). A review of recent literature indicates a revival of interest in the problem (1, 2, 3, 4, 5, 6). It is becoming more apparent that the appraisal of the nutrition of the relatively healthy adolescent or adult is not easy (1). The ultimate goal is the selection of an objective test or tests which will give a reliable indication of the prevalence of malnutrition in a given population and which will select those individuals requiring special attention in order to secure nutritional adequacy.

The procedures which have been used in the past in attempts to provide an adequate means of appraisal have been many and varied (7, 8, 9, 10, 11). Dietary histories and weighed diet records have been used extensively both alone and in conjunction with a physical examination in which special attention has been directed to any manifestations of deficiency states (12, 13, 14, 15). Anthropometric measurements have been used but have proven of little value in screening adult population groups (16,17). More recently biochemical analyses of blood and urine have

played a prominent role in nutritional surveys (18, 19, 20, 21). In general it has been shown that even when carried out simultaneously there is a limited correlation between dietary, physical, and biochemical findings. On the one hand there is the low incidence of clinically recognized deficiency disease and on the other the widespread use of diets below the standards set by the Food and Nutrition Board of the National Research Council and the prevalence of biochemical evidence suggesting inadequate vitamin intake (22).

These inconsistencies may be explained, in part, by the facts that the clinical signs which are diagnostic of a deficiency disease usually result from a long time dietary deficiency whereas the biochemical status at a given time is a composite of tissue stores or deficits and the balance resulting from recent intakes. The dietary history is accurate only for the particular time when the record was kept (22). Moreover, as pointed out by Darby (3), physical signs of deficiency states are not specific, their significance may vary with the population and the incidence of a single physical finding alone does not permit a valid estimation of the incidence within a population. Since variability is a fundamental attribute in biology it becomes impossible to fix a single figure as the requirement for a substance, hence the generalization of the incidence of malnutrition from dietary data alone should be avoided (3). The failure of an individual to ingest a diet satisfying the Recommended Allowances of

the National Research Council in the absence of symptoms of deficiency may suggest only the inadequacy of present standards.

From the foregoing discussion it is evident that nutritional surveys yield information which is essentially presumptive. Such surveys, however, do provide the best means available at present to indicate likely areas of malnutrition(26). As such they are a valuable public health tool and provide a basis for the formulation of public health nutritional and educational programs.

PURPOSE OF THE STUDY

During the winter of 1947 a mobile demonstration unit of the U. S. Public Health Service conducted a nutritional survey of 329 student volunteers enrolled in the Holland High School in an effort to obtain a picture of the nutritional status of this adolescent age group and of the general dietary practices of the community. At the conclusion of the study the data pertaining to hemoglobin, plasma proteins and cell volume, food intakes, height and weight and physical condition of the subjects were presented to the local health authorities. It was planned to use the information as a basis for establishing a public health nutrition program and for determining where the emphasis should be placed in a nutritional education program. However, the value of the data as presented was not clear. The co-operation of Michigan State College and the Michigan State Health Department was obtained to assist in the interpretation of the data and the establishment of an effective educational program.

Since the demands of the community can be met only by helping individuals it was necessary to determine if the data obtained by the mobile unit would serve as an adequate screening device for the selection of those individuals who, although apparently well-growing, might be

suffering from nutritional inadequacies and who would benefit by further investigation. Any dietary deficiency should be corrected since it may develop into a true deficiency state if allowed to continue over a long period of time.

In order to evaluate the information secured by the mobile unit it was decided to conduct a more extensive survey on a smaller yet representative group of the original participants chosen on the basis of the findings in the data. The information to be obtained on this selected group, which, it was hoped, would indicate those individuals having definite health or nutritional problems was to include a more complete dietary history based on a three-day quantitative food record, three hemoglobin determinations, a report of a complete physical examination by a physician, a report of a dental examination by a dentist, all available height and weight records to be plotted on a Wetzel Grid and any information as to the socio-economic status of the individual's family in the community.

On the basis of the additional information it was planned to reclassify the selected group in an attempt to identify those individuals with real health problems which might be associated with nutritional inadequacies. It was hoped that a correlation would be found between the selection of students made from the more extensive data and selection by any one or all of the tests made in the original survey.

BACKGROUND

U. S. Public Health Service Survey

Following the enactment of the Selective Service Act, 40 per cent of the 1941 registrants were found unfit for military service with probably one third of this number suffering from disabilities directly or indirectly related to malnutrition (25). This fact motivated the U. S. Public Health Service to undertake a survey of the nutritional status of several widely separated areas of the country in an effort to determine the underlying cause of the situation before promoting corrective measures. As a result a mobile demonstration unit was assigned to Michigan and, on the invitation of its Health Department, operated in Ottawa County for a period of thirteen months.

The purposes of the mobile units, as they were originally set up, were to do field studies on the prevalence of nutritional deficiency disease from a medical public health standpoint and to test and develop remedial and preventive measures of practical value to public health organizations (12).

The assignment of the unit in Ottawa County was the surveying of one thousand complete families, a random sample of the entire county. However it was found that considerable time would be required before the

laboratory could be equipped to handle a survey of the type required since the micro methods of blood analyses had to be standardized. It was suggested that during this period a study of the high school students in Holland would provide valuable information and in addition would prove useful in introducing the unit to the community. Arrangements were made with the high school authorities for such a survey to be undertaken. The plan of the project was presented to the assembled student body who were asked for their co-operation.

No student was examined without parental consent and of a total enrolment of 800 students 329 or 41 per cent volunteered to participate. The participants ranged in age from 14 to 18 years; 182 were boys and 147 girls. Since only volunteers were examined the group was composed in all probability of those individuals most interested in their own health and hence could not be considered a truly representative sample of the whole student body.

The unit, as it operated in the high school and in subsequent surveys, consisted of a team of highly trained workers who were specialists in various phases of nutrition investigation. The group included a medical officer, a nutritionist, a biochemist, a public health nurse, a laboratory technician and a clerk receptionist. These workers were provided with sufficient laboratory equipment to carry out routine blood analyses. The unit established itself in the Holland High School building during the two week period of the survey.

Each participant was asked to submit a record of his food consumption over a twenty-four hour period, preferably immediately preceding the interview. The record was examined by the nutritionist who, after obtaining any necessary additional information, evaluated the diet on the basis of the essential food groups and made recommendations for improvement. An attempt was made to determine if the submitted record was typical of the individual's dietary pattern.

The physician examined each individual for evidence of nutritional deficiency states as manifest in the condition of the skin, eyes, mouth, tongue, and bony structure. Special attention was directed towards the presence of enlarged thyroids and evidence of rickets. The heart was ausculated through a stethoscope. A DMF* was calculated from a superficial examination of the student's teeth. Height and weight measurements were made by the nurse.

A sample of blood was obtained from a finger prick and used by the biochemist for the determination of hemoglobin, plasma protein, and red cell volume.

In an attempt to make the survey as much a service program as possible a report of all findings - physical, biochemical and dietary - was made to the family physician of each individual. It was hoped that this follow-up would provide a means of stimulating improved nutritional habits in the community.

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*DMF- decayed, missing and filled teeth.

Description of the Community

Holland, a community of approximately fifteen thousand inhabitants, is the most populated center in Ottawa County. It is situated about four miles from Lake Michigan in the south-west corner of the county. Although the area was originally settled by the British, the Dutch took over in 1846 and since that time have become a very consolidated group. Ninety per cent of the population is of Dutch ancestry and, as a group, they exhibit many characteristics typical of the Netherlands. The Dutch population forms a very homogeneous community, frugal and slow to change. For the most part they represent a very inbred group, those who leave the community for the purpose of obtaining additional education usually return to establish themselves in their native environment.

Holland, as the whole of Ottawa County, is relatively prosperous, there being virtually no cases of extreme poverty or malnutrition. The relatively few individuals who are not self-sufficient obtain help through organized church groups rather than through public welfare channels. The average effective buying income per family has been estimated at $3513, the average family consisting of 2.4 persons (27). Ninety-nine per cent of the homes are of wooden construction, the average home consisting of four rooms valued at $3226 and equipped with most modern conveniences (28).

A comparison of the death rate from tuberculosis, maternal mortality and infant mortality on a population

basis between the State of Michigan as a whole and Ottawa County alone indicates that in all cases the rates are considerably lower in Ottawa County. However the total death rate per 1000 population is slightly higher in Ottawa County than in the whole state. Heart disease, cancer, apoplexy and diseases of early infancy were the four leading causes of death in Ottawa County in 1946 (27).

The characteristic homogeniety of the population of Holland together with the fact that the children are a relatively well-growing group receiving generous diets, quantitatively at least, makes it an ideal community in which to conduct a nutritional survey. The resulting information might provide standards applicable to other similar areas.

DISCUSSION OF LITERATURE

Survey Techniques

During the past four decades nutrition workers have been conducting mass surveys in an attempt to determine the extent of malnutrition in the population especially among school children. In the period from 1906-1919 the majority of the reports were based on routine medical examinations alone and no attempt was made to correlate medical findings with food intakes (29). One series of investigations was based on the adequacy of breakfasts consumed (76) and at least one study incorporated a report of food consumption as obtained through a home visit (77). From 1919-1924 the emphasis was placed on the use of height and weight standards as an indication of nutritional status (29).

After 1924 the dietary survey involving records of food consumption was used extensively in assessing the nutritional status of population groups. These dietary histories were obtained often in conjunction with a physical examination (11, 30, 32). The survey techniques and the methods of analysis varied considerably with the investigator and with the purpose of the study (31, 33, 34, 35).

Mack et al (36) in their work in Pennsylvania were among the first investigators to attempt to correlate dietary findings with the response to a series of nutritional status tests. About the same time Kruse (2) made an extensive survey designed to evaluate both the older methods and the newer diagnostic methods of appraising nutritional status. The main objective of this study was to select and organize the methods which would be most reliable and sensitive in detecting dietary deficiencies and which would be most practical when applied to surveys.

Huenemann and Turner (37) criticized the use of dietary histories obtained by an interview with the subject as a source of quantitative data in that the results obtained might lead to erroneous conclusions. These investigators based their criticism on the results of a study of 25 clinic patients 6 to 16 years of age. A diet history was obtained through an interview with the child and his mother and a weighed two week food intake record was kept immediately following the interview. This procedure was repeated three or four times per year. A comparison of the results showed that no history agreed within 20 per cent with the diet record and also that there was a variation in the intakes for all nutrients between successive records. One half of the records differed significantly from the histories in five or six nutrients. On the basis of these findings they recommend the use of repeated dietary samples if a correlation is to be

established between a clinical and a dietary report. However, these investigators do not consider the possibility of a modification in the regular dietary pattern during the period when weighed records are being kept which might account for a part of the discrepency noted. The fact that the tables of food composition used in calculating the dietaries could provide an even larger source of error than the errors in recording the intake would argue against the value of the more expensive use of weighed records when a direct analysis of the food consumed is not made.

The opposite view is taken by Burke (38) who maintains that a diet history which yields data on the average dietary intake over a considerable period of time is a valuable tool when it is desired to correlate dietary findings with clinical and laboratory findings. The method suggested for securing such a history is to interview the subject and obtain information in ordinary household measurements as to his usual pattern of food consumption. This history is substantiated by a check list of food likes and dislikes and finally by a three-day food record. From the combined records, of which the three day record is considered the least valuable, a typical day's dietary is drawn up and calculated. A rating scale is suggested to avoid an unjustifiable impression of accuracy. The range of values for each rating should be wide enough to absorb any of the inaccuracies of the diet history.

Darby (3) has shown that the calculated and analyzed values for sample meals agree reasonably well especially when the mean values are considered. The best agreement was found in the low intake range.

In 1942 the U.S. Public Health Service (39) recommended the assessment of the nutritional status of a population by a series of tests on a suitable population sample. The survey was to be comprised of a properly planned dietary and food intake record and an adequate physical and medical examination to include a slit lamp examination of the eyes and the determination of hemoglobin, blood proteins and plasma ascorbic acid concentration. It was pointed out that these tests gave incomplete information but that complete studies would have to await the development of additional methods. Essentially the same procedure was followed by Youmans et al (40) who conducted a study on a rural population of Tennessee for the purposes of obtaining a picture of the nutritional status of that group and of evaluating both new and old diagnostic tests. Youmans, however, included a much more elaborate series of laboratory tests to aid in the detection of subclinical or latent forms of deficiency disease.

McHenry et al (14) undertook a study of high school students in an effort to test the validity of several recommended procedures and to determine whether the results of dietary studies would be in agreement with those obtained by other methods of nutritional

appraisal. They concluded that dietary records did not give a reliable assesment of nutritional conditions, that the standards in current use were too high in many respects and that the methods of study used were not sufficiently sensitive to detect nutritional inadequacies. They advocate the use of diet records as useful, and physical examinations as essential in conducting surveys but question the possibility of assessing nutritional status in the absence of definite clinical signs.

The characteristics which an individual test for a particular deficiency disease should possess before being considered applicable to the appraisal of nutritional status have been outlined by Kruse (4). The method should be simple, quick, easy, reliable, and feasible. It should be objective rather than subjective and applicable to all age groups. The method should not require too much expensive equipment or the services of highly trained personnel. Kruse questions the value of biochemical and microbiological blood determinations in that they have very narrow limits in appraising nutrition beyond which they are misleading. Once chronic changes have appeared, blood values may be unreliable.

Dietary Studies

The results of dietary investigations on students of high school age are presented in Table 1 and in Table 2.

These results indicate considerable variation in diet patterns between various sections of the country and

also between various socio-economic groups. Workers in all parts of the country agree that there is a general improvement in dietary practices with an increase in family income and spending power (10, 11, 34). Mack (36) found that the educational attainments of the parents was an influential factor in determining the dietary practices of the family.

Dental Studies

Comparatively few studies have been made on the dental health of children of high school age. The results of some such studies have been tabulated and are presented in Table 3.

Boyd (53) was unable to offer an explanation for the lower incidence of dental decay among diabetic children in comparison with normal children. He did note that the diets of these children contained liberal amounts of milk, eggs, meat, fresh and canned fruits and vegetables and cod liver oil daily. Whether it was the absence of sweets from their diets or the fact that they were receiving an adequate diet in most respects which is the contributing factor towards reduced caries incidence is subject to controversy. Thirty-four per cent of the 54 children studied showed no increase in caries incidence during a period ranging from 50 to 99 months.

The apparent disparity between the incidence of dental decay and dental care of these defects among children in Hagerstown, Maryland, was studied by Klein and Palmer (54).

Table 1: Percentages of individuals in groups of high school students with intakes of specific nutrients as reported in the literature at less than 80 per cent of the recommended levels.

Investigator	No. of Subjects	Age	Calor-ies	Pro-tein	Cal-cium	Iron	Vit. A	Thia-min	Ribo-flavin	Ascorbic Acid
*Mack, P. B. (42) Wilkes Barre, Pa.	39	13-20	100	87	95	90	72	87	100	79
*Wiehl, D. (43)	2037	13-20	33	11	38	29	47	22	36	36
New York (44)	293	13-18	29	7	32	12	22	4	10	7
*Youmans, J. B. (40) Tennessee	113	Adol. White	56	42	65	55	42	76	63	56
	76	Colored	89	74	75	69	47	89	86	55
*Mack, P. B. (46) Philadelphia	38	13-20	50	21	71	50	50	36	50	50
McHenry, E. W. (14) East York	546	13-17	19	12	35	18	10	80	31	85
Sylvestre, J. E. (41) Quebec City		11-18	9	14	89	20	69	66	...	8
McHenry, E. W. (47) Toronto		11-18	16	11	27	22	12	55	...	21
*Present Study Holland, Mich.	40	15-18	18	5	22	5	43	20	13	95

*Figures based on 75 per cent of the recommended levels.

Table 2: Average intake of specific nutrients by adolescent groups as recorded in the literature

Investigator	Sex	No. of subjects	Age	Calories	Protein gms.	Calcium gms.	Iron mgs.	Vitamin A I.U.	Ascorbic Acid mgs.
Foote, R. (48)	M	29	14-19	3126	90	1.44	18.2		
Texas	F	23	14-19	2017	53	.79	9.4		
Leichsenring J.M.(49)	F	524	14-17	2285	69.8	.78	12.2	5982	81
Minnesota and Kansas									
Wiehl, D. (43)									
New York									
Private School	M	353	14-18		125	1.56	21.3	12033	117
	F		14-18		90	1.11	15.6	8070	117
Public School	M				108	1.19	16.5	5544	83
Jewish	F				76	.93	11.6	3915	83
Italian	M				100	1.00	14.6	7858	60
	F				74	.79	11.7	5607	60
Youmans, J.B. (40)	M	19	13-15	2494	83				
Tennessee	F	18	13-15	1691	48				
	M	34	16-20	2723	87				
	F	21	16-20	1975	60				
Robinson, W.D. (16)	M	23	16-19	2800	91	1.94	22.0	4590	62
Mexico City	F	24	16-19	2367	74	1.74	16.4	3790	39
Dols, M.J. (31)			14-20	2110	62	.66	18.0	2672	111
Netherlands									

Table 3: DMF of adolescents as recorded in the literature.

Investigator	Age	No. of subjects	Total DMF	Decayed	Missing	Filled
Klein and Palmer (50)	14	695	5.61	3.1	.8	1.9
Hagerstown, Md.	15	651	6.6	3.1	1.1	2.6
	16	445	7.2	2.9	1.2	3.3
	17	355	7.7	2.3	1.4	4.2
	18	148	8.7	2.5	2.0	4.4
Knutson, J.W. (51)	14	159	7.7	2.6	.5	4.9
Minnesota	15	142	9.6	3.0	.8	6.1
	16	93	9.6	2.2	1.0	6.5
	17	79	10.8	2.2	1.1	7.9
	18	24	11.2	2.3	1.1	8.2
Schour and Massler (57)	11-15	475	1.05			
Italy	16-20	247	2.02			
New Jersey	13-15		4.66			
	16-20		8.50			
New Jersey	13-15		8.06			
Dutch Children	13-15		2.99			
Italian Children	13-15		.90			
Philadelphia	11-15		4.66			
	16-20		8.50			
Present study	15-18	19 boys	11.7	2.2	.8	8.3
Holland, Mich.	15-18	20 girls	13.5	1.5	1.3	10.4

They found that the incidence of dental caries increased at the rate of .6 permanent teeth per child per year whereas the defects were repaired at a rate of only .4 permanent teeth per year. This disparity has been shown to account for an average of about one and one-third permanent teeth extracted or with only the roots remaining per high school child.

Klein and Palmer (55) have demonstrated that the time of eruption of teeth per se bears no relationship to the attack of the lower permanent molars by caries. That dental caries are found most often in children with a known history of rickets has been shown by Eliot et al (56) from data on children up to 12 years of age. Whitacre (58), in a study of dental decay among Texas school children, found a higher incidence of dental decay among the white children than among the Mexican and Negro children. Similarly, Schour and Massler (57) have indicated an average DMF among children in the United States which is seven times as high as that recorded for Italian children. They also pointed out that although Dutch children have a higher DMF than Italian children it is still considerably lower than that of American children.

That 64 per cent of the caries in the upper jaw and 87 per cent in the lower jaw are contributed by six year molars has been shown by Klein, Palmer, and Knutson (59). They also reported that 40 per cent of the deciduous teeth of elementary school children contain unfilled cavities and that only 16-20 per cent of the DMF surfaces

in boys and girls are replaced by fillings. Whitacre (58) found that 40 per cent of all teeth affected by caries were six year molars.

Among young soldiers inducted into the army those from Michigan were shown by Nizel and Bibby (60) to have the eighteenth highest DM (decayed and missing teeth) rate of all the states. The New England states had the highest rates and the southern states had the lowest. The rate for Michigan was 10.27 DM per person.

Hemoglobin Studies

The value of a single hemoglobin determination as used in nutritional surveys is questioned especially when a deviation of its value from an accepted norm is considered indicative of a state of anemia (61). As pointed out by Wiehl (62) the problem in interpreting hematological findings among apparently healthy adolescents is the lack of criteria for identifying abnormal or pathologically significant variations. Wiehl also found a definite increase in the hemoglobin content of the blood of both boys and girls during adolescence.

A daily variation in hemoglobin values as great as 2.5 grams per 100 ml. of blood was reported by Wilkins and Blakely (61) as the result of an examination of 810 school children. Since only two samples, one in the morning and one in the afternoon, were taken from each individual the maximum daily variation probably was not obtained. Data on morning and afternoon hemoglobin determinations on 651 adults and children showed an appreciable variation during the day, the lower levels being recorded in the afternoon followed by a rise in the evening. These same investigators reported that capillary blood gave somewhat higher values than did venous blood. Excitement and mid-morning meals were found to have no effect on hemoglobin levels whereas exercise caused a significant increase.

The hemoglobin values reported by McCarthy and Van Slyke (63) on 18 young men showed an average daily range of 6.5 per cent of the mean hemoglobin content for

the day with an usual decrease in the evening as compared to the morning values. However, an individual showing one pattern of change one day would show an entirely different one the next day. Similar results were reported by Brown and Goodall (64) who in examining the hemoglobin levels of 24 individuals found an average daily variation of 6.3 per cent of the mean value and were unable to detect any uniform direction of change during the day. They also noted that the more frequently the estimations were made the greater the variation noted. On the other hand Mole (65) was unable to detect any significant change in hemoglobin values during the working day but found a four per cent drop between nine in the morning and eleven at night.

The fact that such a wide variation in hemoglobin values can occur in one day indicates the caution that must be used in interpreting single observations or minor deviations from accepted standards (61). Ohlson et al (66) suggested that normal standards of hemoglobin be interpreted as a range of values which is wider than the range of values generally accepted. Wiehl (67) points out the necessity of using standards which have been derived from a sample which is representative of the persons to whom it is applied.

Leichsenring et al (68) in a study of the blood of high school girls found an average hemoglobin content of 12.21 grams per 100 ml. of blood. They attribute these low levels to the rapid acceleration in the rate of growth of girls which begins one or two years before the onset of

menstruation and reaches its peak around the thirteenth year and then begins to decline. The lowest levels were found among girls who had been menstruating for two or three years. These investigators conclude that the rate of growth has a greater effect on hemoglobin values than does the periodic loss of blood.

EXPERIMENTAL PROCEDURE

The original data on Holland High School students collected by the U. S. Public Health Service mobile demonstration unit in February 1947 were analyzed in the following manner. The 329 students were grouped according to age and sex. For each individual grouping the average and the standard deviation were calculated for each of the following measurements - height, weight, height-weight ratio, plasma protein, hemoglobin and red cell volume. Two experimental groups of students were chosen; one (BD) was composed of ten boys whose measurements deviated from the mean of their own age group by at least one and one half times the standard deviation in at least two and, in most cases, three of the measurements; the other (GD) was a group of ten girls chosen in the same manner. As far as possible each group (BD and GD) was balanced as to the number deviating above and below the mean. Two groups, (BC and GC), each composed of ten students whose measurements corresponded most closely to the mean measurement of the age and sex group of the original distribution, in at least two measurements, were chosen as controls.

Through the efforts of the Ottawa County Health Department permission was obtained to conduct an extensive survey on the small group of forty students. The cooperation of the school authorities was assured.

The selected group was assembled and the plan of the proposed survey was outlined. Forty students volunteered to participate. Since parental permission for the collection of blood samples had been obtained during the original survey, it was not obtained again. All interviewing and testing was arranged during the students' study hours so as to interfere as little as possible with the routine of the school. A dining-room in the high school was made available for the use of the interviewer. Each student was interviewed first for a fifteen minute period during which the purpose and nature of the study was explained further. General information concerning the student's background and family life was obtained. Each student was asked to keep three twenty-four hour food intake records. The form provided for such records is shown in the Appendix. The days chosen were to be non-consecutive. The student was asked to select days on which the diet was most typical of his regular diet pattern and to avoid the use of Sundays and holidays or any other days on which the dietary habits were irregular. When these records were submitted the interviewer discussed them with the student to obtain more complete information regarding the intake and to determine if the observed pattern was typical. The student's height was measured against a yard stick attached to the wall. The subjects were weighed on platform scales provided by the Physical Education Department of the high school.

Each student was interviewed the second time for a period of one hour. Each individual was asked to complete a questionnaire of a general nature and also one concerning past medical history. The forms used are shown in the Appendix. The completed forms were reviewed by the interviewer who then obtained additional and more complete information by direct questioning. Height and weight measurements were checked. A hemoglobin determination was made on a sample of blood obtained from a finger prick. The blood was collected on a wax mold on which there was a minute amount of heparin to prevent coagulation. The hemoglobin was determined by the Newcomber Acid Hematin method (78).

During the third interview, a second hemoglobin sample was obtained and a third check was made on height and weight measurements. The diet records were submitted at this time.

At the time of a fourth interview a third hemoglobin determination was made for each participant. Any information required to complete the individual's record was secured at this time.

In February, 1948, a finger-tip sample of blood was obtained from 37 of the 40 participating students. This sample was analyzed for ascorbic acid, phosphatase, carotene and vitamin A content*.

All participants in the study were given a thorough dental examination by a dentist of the school dental

clinic*. The dentist recorded all cavities, fillings, abcessed and missing teeth, and assessed the oral hygiene of the individual. This information was recorded on the dental form shown in the Appendix. Through arrangements made by the Ottawa County Health Department, the cooperation of a local physician* was obtained to make a complete physical examination of the subjects. This information was recorded in the form shown in the Appendix.

Since the results of any tuberculin tests or x-rays were not available to anyone outside the employ of the county health department a member of the staff in both Holland and Grand Haven checked the files for any available records on the students or their families.

Considerable information regarding the socio-economic status of the families of the individual participants was obtained through interviews with several Junior and Senior High School teachers who were well acquainted with the community and many of the families represented in the study.

The records on file with the Ottawa County Health Department were checked to determine if any of the students under consideration came from families who had been under the care of public health agencies at any time. The nature and extent of such care or assistance was recorded.

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The records of the Bureau of Social Agencies, an office through which all social and welfare work in Holland is cleared, were checked to find out if any of the families under consideration had received in the past or were at the time of this study receiving material or financial aid. The extent, nature and exact period of such assistance was recorded.

An examination of the school files revealed a considerable number of health cards which contained records kept by the grade school which the student had attended. These records included information as to the number of days absent from school, dates of childhood illnesses, immunization records, height and weight records and a report of an annual physical examination. These records were not available for all of the students concerned and the detail of the information varied depending on the school previously attended. All pertinent information present on the cards was recorded.

An annual physical examination is required of all high school students who enroll in physical education classes. The reports of these examinations provided information as to blood pressure, pulse rate, condition of the teeth, lungs, heart, tonsils, and thyroid gland, posture, height and weight and general condition. The records were not available for seniors since they are not required to participate in physical education classes and their earlier records had been discarded. Each student was asked to submit all records of his height and weight

available to him from other sources.

The data collected were tabulated and subjected to suitable statistical analysis.

METHOD OF ANALYSIS AND RESULTS

The three-day diet records kept by each individual were tabulated and analyzed for specific nutrients by the short method of dietary analysis as outlined by Donelson and Leichsenring (23). The average daily intake of each individual was calculated and the results are on file in the Home Economics Department at Michigan State College.

From these individual daily averages, the average intakes for each of the four groups BC, GC, BD, and GD - were calculated. The two deviant groups BD and GD were further divided into four subgroups BD+, BD-, GD+, and GD-, plus indicating those students who were selected because their measurements were greater then the average for their own age and sex group, and minus indicating those whose measurements were smaller than their own group average. Average intakes for each of these subgroups also were calculated. All these results are shown in Table 4.

The diet records were checked for the number of servings of the following food groups consumed - milk, green and yellow vegetables, citrus fruit and tomatoes, whole grain and enriched cereal products, meat, fish, and poultry, and sweets (69). On the basis of the three day record the average number of servings per week was calculated. These results are tabulated in Table 5.

Table 4: Average daily intake of specific nutrients by groups.

Group	Calories	Protein gms.	Carbohydrate gms.	Fat gms.	Calcium gms.	Phosphorus mgs.	Iron mgs.	Vitamin A I.U.	Thiamin mgs.	Riboflavin mgs.	Niacin mgs.	Ascorbic Acid mgs.
BC	3120	125.3	335.8	140.0	1.65	2.17	19.5	8034	1.73	3.24	20.1	76.6
BD	2695	99.5	312.9	122.1	1.05	1.15	17.0	4480	1.56	2.24	17.4	52.7
GC	2343	85.7	278.5	97.9	1.03	1.50	15.4	11938	1.68	2.17	14.2	93.2
GD	2388	86.1	282.2	98.3	1.08	1.49	14.1	4422	1.29	2.18	13.8	75.3
BD+	2952	110.3	348.0	135.5	1.11	1.69	18.3	4939	1.71	2.35	18.4	59.5
BD-	2307	83.3	260.2	102.2	.96	1.49	15.2	3791	1.33	2.08	15.7	42.4
GD+	2214	79.1	277.0	88.7	1.09	1.40	12.9	4864	1.15	2.06	12.3	82.1
GD-	2504	90.7	284.7	104.7	1.07	1.55	15.0	4127	1.37	2.26	14.8	70.8

Table 5. Average intake of food groups recorded as number of servings per week.

Group	Milk	Green and Yellow Vegetables	Citrus Fruit and Tomatoes	Meat, Fish and Poultry	Whole Grain Products	Sweets
BC	31.0	6.5	6.9	19.0	44.1	26.3
BD	14.9	4.7	2.8	15.0	31.7	23.2
GC	16.4	9.1	9.0	11.7	30.0	19.2
GD	17.9	6.6	6.1	11.9	22.4	26.5
BD+	13.9	5.7	4.1	18.0	39.4	27.0
BD-	16.3	4.1	1.4	14.0	27.1	22.3
GD+	16.9	7.0	7.0	10.5	17.5	30.1
GD-	19.1	6.4	5.6	12.8	25.7	24.3

A comparison of the individual dietary intakes of nutrients with the daily allowances recommended by the National Research Council (70) was made. The number of students in each group receiving less than 75 per cent of the recommended allowance for each nutrient is shown in Table 6. The number of the group whose food intake indicated possible inadequacies but who were receiving vitamin supplements is indicated also.

From the reports of the dental examinations a DMF was calculated for each individual. The DMF represents the total number of teeth which were either decayed, missing or filled regardless of the number of fillings which might be present in any one tooth. A single tooth which contained both cavities and fillings was recorded as a filled tooth. Since a considerable number of teeth which are recorded as carious or filled contain more than one cavity or filling another score, the CAMF, was calculated. This figure represents the total number of cavities and fillings plus the number of missing or abscessed teeth. The CAMF does not consider the area of the tooth surface affected as does the dental caries index suggested by Bodecker (71). The assessment of the oral hygiene of the individual was summarized on a numerical basis (good-3 points, fair-2 points, poor-1 point). These data are presented in Table 7.

Dietary intakes of protein, ascorbic acid, and vitamin A were correlated with the corresponding blood level of these nutrients as determined by the U.S. Public Health Service biochemist. The results are shown in Table 8.

Table 6: Number of students receiving less than 75 per cent of the National Research Council Recommended Allowance for specific nutrients

Group	Calories	Protein gm.	Calcium gm.	Iron mgs.	Vitamin A I. U.	Thiamin mgs.	Ribo-flavin mgs.	Niacin mgs.	Ascorbic acid mgs.
NRC Standard	3800	100	1.4	15	6000	1.8	2.5	18	100
BC	5	0	3	0	5	2	1	1	5
BD	6	2	5	0	7	6**	3	3	9
BD+	3	1	3	0	4	3*	1	2	5
BD-	3	1	2	0	3	3*	2	1	4
NRC Standards	2400	75	1.0	15	5000	1.2	1.8	12	80
GC	1	0	1	1	1	0	1	0	1
GD	1	0	0	1	4*	0	0	1	4
GD+	1	0	0	1	1	0	0	1	1
GD-	0	0	0	0	3*	0	0	0	3

* Each asterick indicates one student receiving a supplement.

Table 7: Average DMF, CAMF and oral hygiene assessment by groups

Group	Decayed	Missing	Filled	Total DMF	Cavities	Fillings	CAMF	Oral Hygiene *
BC	2.6	.8	8.8	12.2	4.8	12.4	18.0	2.2
BD	3.5	1.1	6.6	11.2	7.0	10.2	18.4	1.9
GC	1.3	2.0	9.3	12.6	3.1	12.8	17.9	2.5
GD	2.4	.7	11.3	14.4	4.0	16.1	21.2	2.5
BD+	3.2	.5	6.8	10.5	6.8	10.5	18.0	1.8
BD-	4.0	2.0	6.2	12.2	7.2	9.7	19.0	2.0
GD+	3.8	.0	8.5	12.1	6.0	12.3	18.7	2.5
GD-	1.5	1.2	13.1	15.8	2.6	18.6	22.9	2.5

* based on the scores: good - 3 points
fair - 2 points
poor - 1 point

The mean plasma levels for vitamin A, carotene, ascorbic acid and phosphatase are recorded in Table 9. Individual values for these blood constituents are presented in Table 10.

Individual hemoglobin values are presented in Table 10. This table includes a record of the difference between the original single hemoglobin determination and the average of the three determinations made in the present survey. These data are summarized in Table 11 which also includes the age of onset of menstruation among the girls.

By means of scatter diagrams an attempt was made to correlate the DMF and the CAMF with such dietary factors as total caloric intake, carbohydrate, calcium, ascorbic acid and the number of servings of sweets per week. In cases where there seemed to be some correlation between the two variables a correlation coefficient was calculated. These values are included in Table 8.

In cases where height and weight measurements were available for at least three previous periods over at least five years a growth pattern was plotted on the Wetzel Grid (72). All marked deviations from the regular growth channel of the individual were investigated by reference to the past medical history in an effort to explain the divergence. Representative growth curves are shown in Figures 1 and 2. Similar charts for other individuals are on file in the Home Economics Department at Michigan State College.

Figure 1: Growth patterns typical of students in the control groups.

GRID for Evaluating PHYSICAL FITNESS

in Terms of PHYSIQUE (Body Build), DEVELOPMENTAL LEVEL and BASAL METABOLISM

— A Guide to Individual Progress from Infancy to Maturity —

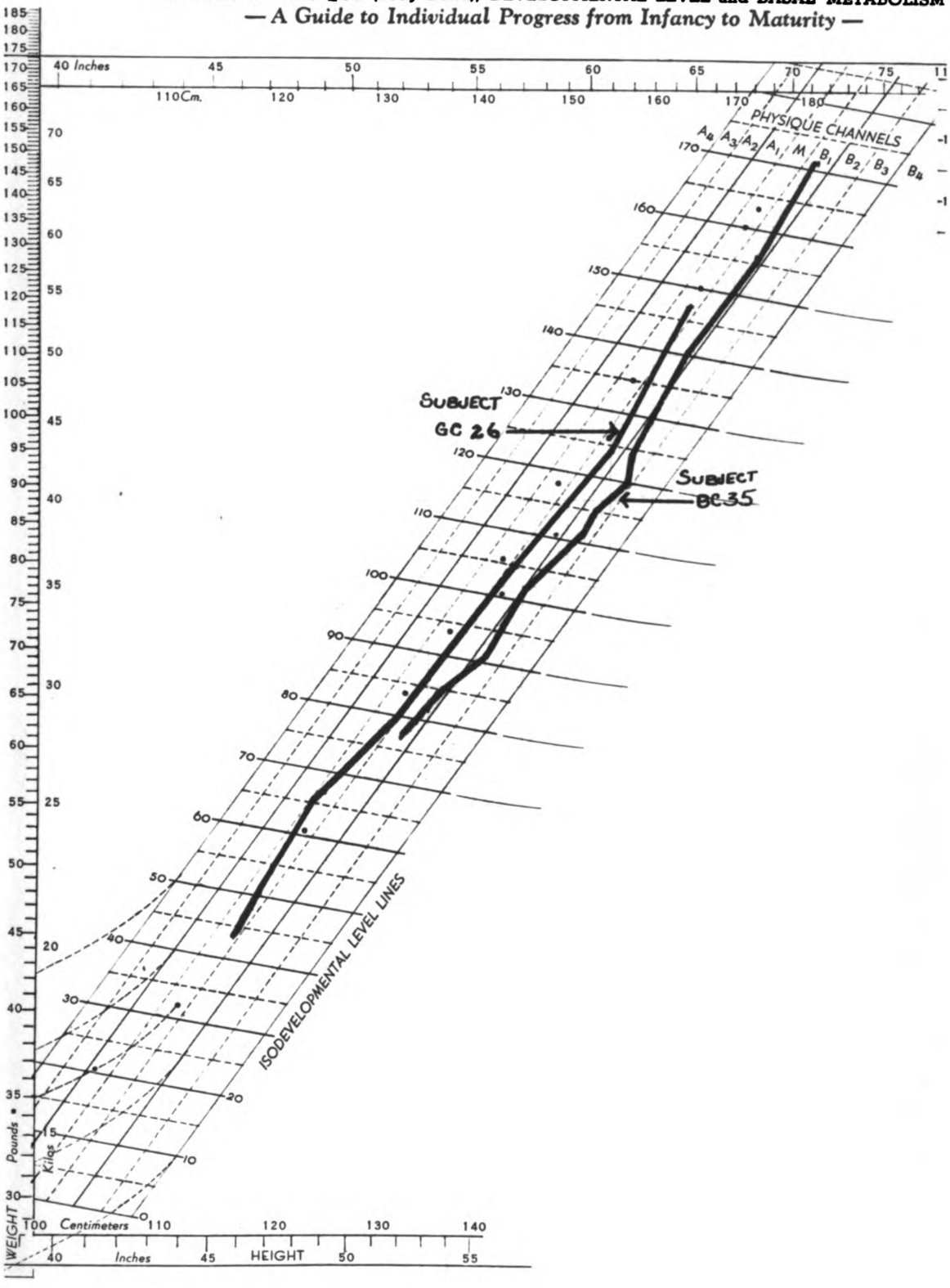

Figure 2: Growth patterns typical of students in the deviant groups.

GRID for Evaluating PHYSICAL FITNESS

in Terms of PHYSIQUE (Body Build), DEVELOPMENTAL LEVEL and BASAL METABOLISM

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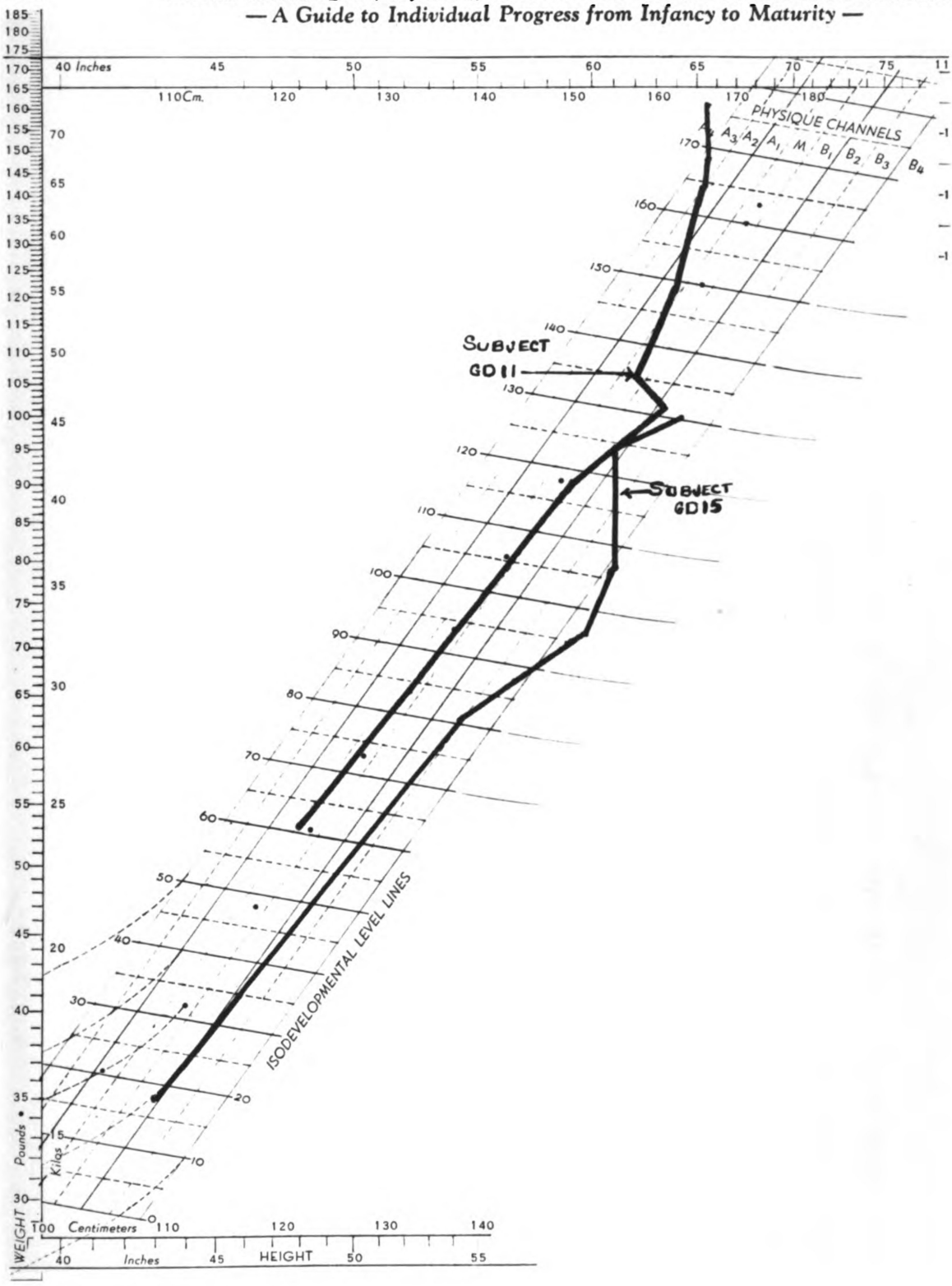

Table 8: Correlation between dietary factors, dental findings and blood analyses.

Variables	Correlation Coefficient	Degrees of Freedom
Calcium / CAMF	0.19	38
Calcium / DMF	0.26	38
Carbohydrate / CAMF	0.09	38
Protein Intake / Plasma Proteins	0.16	33
No. of Servings of Sweets / DMF	0.32*	38
Vitamin A Intake / Serum Carotene	0.23	36
Vitamin C Intake / Plasma Ascorbic Acid	0.48**	36

* One chance in 20 that the results are fortuitous

** One chance in 99 that the results are fortuitous(73)

Table 9: Average concentration of specific constituents of the blood.

Group	Ascorbic Acid mgms. %	Vitamin A μgms./100 ml.	Carotene μgms./100 ml.	Phosphatase Bodansky Units/100 ml.
BC	.55	41.0	95	7.3
BD	.49	43.4	69	8.1
GC	.99	35.5	103	3.3
GD	.74	55.0	86	4.9

Table 10: Individual Blood Findings:

Group BC

Subject No.	Age	Hemoglobin Min. gms.	Max. gms.	Range gms.	Average gms.	Deviation* gms.	Vit. A µgms.	Carotene µgms.	Ascorbic Acid mgm.	Phosphatase Bodansky Units
30	17	11.38	12.63	1.25	11.97	-2.23	--	--	--	--
32	17	13.75	16.23	2.48	14.78	-1.32	47	62	.79	4.2
33	17	13.33	16.23	2.90	14.78	+0.58	47	137	.60	6.4
34	17	14.03	15.43	1.40	14.96	-0.64	34	101	.25	5.0
35	16	12.63	13.33	0.70	13.10	-1.20	29	75	.40	15.3
36	16	14.03	14.90	0.87	14.47	-0.43	46	113	.25	7.2
37	16	15.78	15.78	--	15.78	+1.48	42	125	1.01	8.0
38	17	13.09	13.75	0.66	13.53	-0.67	52	111	.65	6.6
39	16	12.91	15.60	2.69	14.18	-0.02	26	56	.30	4.8
40	16	13.75	14.03	0.28	13.84	-0.36	42	85	.80	8.6
Group BD										
31	17	16.23	17.59	1.36	17.14	+1.04	45	67	.77	5.0
41	17	12.05	16.23	4.18	14.20	-1.70	59	86	.45	8.1
42	15	11.48	12.40	0.92	12.07	-0.93	31	91	.62	9.5
43	17	12.51	13.75	1.24	13.05	+0.15	42	67	.22	14.4
44	17	14.38	17.59	3.21	16.52	+0.49	37	34	.25	5.0
45	18	16.91	17.81	0.90	17.43	-0.57	56	106	1.27	4.1
46	16	11.29	14.03	2.74	12.77	+0.16	37	48	.27	15.5
47	15	12.63	12.91	0.28	12.77	-0.23	35	63	.42	8.1
48	16	14.03	16.23	2.20	15.05	-1.35	51	97	.34	4.4
49	16	12.63	13.75	1.12	13.09	-0.11	41	32	.31	6.7

* Deviation of average hemoglobin value of present study from single determination of original survey.

All values based on 100 ml. of blood.

Table 10 - continued

Group GC

Subject No.	Age	Hemoglobin Min. gms.	Max. gms.	Range gms.	Average gms.	Deviation* gms.	Vit. A µgms.	Carotene µgms.	Ascorbic Acid mgm.	Phosphatase Bodansky Units
21	17	10.81	12.63	1.82	11.63	-1.97	41	115	1.25	3.1
22	17	11.48	12.91	1.43	12.30	-0.40	31	111	0.78	4.5
23	16	12.40	13.89	1.59	12.97	-0.83	36	87	0.57	2.2
24	16	10.71	11.71	1.00	11.26	-1.74	31	80	1.48	2.4
25	17	10.44	11.48	1.04	11.07	-2.73	31	84	0.53	4.1
26	16	12.40	12.63	0.23	12.47	-0.43	11	32	0.54	4.3
27	16	11.48	12.91	1.43	12.33	-0.77	60	181	1.43	1.6
28	16	11.00	13.75	2.75	12.07	-1.13	--	---	----	---
29	16	12.63	12.63	0.00	12.63	-0.77	32	121	1.24	3.4
60	17	12.05	13.33	1.28	12.67	-1.13	47	113	1.13	4.1
Group GD										
10	16	13.75	14.38	0.63	13.94	-0.06	41	104	0.30	4.0
11	15	13.61	13.61	0.00	13.61	0.00	45	115	1.90	3.7
12	17	12.91	14.03	1.12	13.65	-2.50	176	75	0.99	5.9
13	16	12.05	12.60	0.55	12.27	+0.77	34	89	0.30	3.2
14	17	10.36	11.71	1.35	10.86	-2.44	--	---	----	---
15	15	11.38	12.91	1.53	12.40	-2.70	46	87	0.57	6.2
16	17	11.29	12.05	0.76	11.67	-2.53	31	116	0.45	4.0
17	16	12.40	12.91	0.51	12.74	-1.26	50	74	1.25	6.2
18	16	11.19	12.05	0.86	11.62	-2.38	41	57	0.53	4.3
19	16	12.63	12.63	0.00	12.63	-0.93	32	60	0.36	7.2

Table 11: Summary of hemoglobin findings

Group	Present age	Hemoglobin gms./100 ml.	Range*	Deviation from single determination**	Age at onset of menstruation
BC	17.0	14.14	1.32	- .48	
BD	16.7	14.52	1.82	- .31	
GC	16.8	12.41	1.25	-1.19	12.4
GD	16.5	12.53	.73	-1.42	13.7
BD+	17.2	15.90	2.16	- .37	
BD-	16.2	12.66	1.29	- .21	
GD+	16.3	13.37	.82	-1.31	12.3
GD-	16.6	11.97	.67	-1.49	14.5

** Based on values obtained by the Mobile Demonstration Unit of the U. S. Public Health Service in February, 1947.

* Indicates difference between minimum and maximum values of three determinations.

Any information obtained through the general questionnaire or during the interviews which added validity to the interpretation of the data was tabulated. These results are presented in Table 12.

The distribution of vitamin supplements among experimental groups is shown in Table 13. The nutrients for which an improvement in dietary practices was recommended during the original survey are tabulated in Table 14. It also indicates the number of specific cases of individuals to whom recommendations had been made during the original survey, who in the more extensive one, were found to be ingesting these nutrients in amounts satisfying the National Research Council Recommended Allowances.

Table 12: Summary of information reported in general questionnaire and during interviews

Group	No. of Moves while in community	No. of rooms per person	No. in family	Parents' education*	Education of brothers and sisters	No. of meals eaten out per week	No. of hours of work after school	No. of communicable diseases
BC	1.9	2.5	5.1	10.4	13.1	1.0	15.1	4.5
BD	1.4	1.4	6.5	9.6	11.2	3.1	6.5	3.5
GC	1.6	1.4	6.2	10.2	13.9	2.2	4.7	3.6
GD	.8	1.4	6.4	10.4	11.6	2.9	4.7	3.7

* measured by grade of school completed.

Table 13: The distribution of vitamin supplements received by individual students

Group	Vitamin A	Thiamin	Riboflavin	Niacin	Ascorbic Acid	Vitamin D
BD	0	2	0	0	0	0
BC	0	0	0	0	0	0
GD	2	0	0	0	0	1
GC	5	3	3	3	3	1

Table 14: Specific nutrients for which inadequacies were noted during the original survey and cases in which improvement was found in the present study.

Group	Protein	Calcium	Vitamin A	Thiamin	Riboflavin	Ascorbic Acid
BD	0	0	3 (1)	1	3 (3)	3
BC	0	0	1 (1)	1	3	3
GC	3 (1)	0	2 (2)	0	4 (2)	1 (1)
GD	2 (2)	1	2	0	4 (2)	3 (1)

Numbers in parenthesis indicate the number of individuals originally considered deficient in a specific nutrient who, in the three-day record, ingested the full recommended allowance of that nutrient.

DISCUSSION OF RESULTS

A comparison of the average daily intake of different nutrients of the deviant and the control groups indicates that among the boys the deviant group consumed considerably lower amounts of all nutrients. However, among the girls appreciable differences in intake were noted only in respect to vitamin A, thiamin and ascorbic acid. The consumption of these nutrients was lower in the deviant than in the control group. In all other respects the intakes of the two groups of girls were essentially equal.

Within the deviant group of boys, subgroup BD+ had a higher consumption of all nutrients than did subgroup BD-. Among the girls, subgroup GD+ had a greater intake of ascorbic acid and vitamin A than did subgroup GD-. For all other nutrients the opposite situation was true.

The range of individual intakes is very wide for all nutrients, but especially for vitamin A and vitamin C. Even where mean differences were noted there was no appreciable difference in the range of values among the various groups.

With the exception of two students who were receiving cod liver oil supplements the participants in this study had no measurable source of vitamin D in their diets. As a group they consumed practically no fish. The combined facts that the holland area is one of high fog and low sunshine and that the majority of the students worked during

the summer months and would not be exposed to much sunshine would limit the possible effect of irradiation for vitamin D production. If low vitamin D can be considered a nutritional defect among these children it might account in part at least for the high incidence of dental caries noted.

Seventy-five per cent of the National Research Council recommended Allowances was considered as an arbitrary minimum standard to promote nutritional adequacy. Among the girls dietary deficiencies of vitamin A and vitamin C were found four times as often in the deviant group as in the control group.

Based on the same standards there seems to be a greater dietary inadequacy among the boys studied than among the girls. Vitamin C, vitamin A, calories and calcium are the most prevalent deficiencies but are followed closely by riboflavin and niacin. The fact that such a large number of all the boys of this series who are apparently growing well fail to ingest even 75 per cent of the recommended dietary allowances for specific nutrients might indicate that the current standards are too high unless we can assume a serious depletion of stores to meet immediate growth needs.

Among the boys, the control group received a greater number of servings of the protective foods - milk, green and yellow vegetables, whole grain products, and meat, fish and poultry - then did the deviant group. The control group of boys also consumed a greater amount of sweets than did the deviant group. The grouping 'sweets' included sugar,

jelly, jam, syrup, candy, soft drinks and candy bars. The deviant group was very low in its consumption of citrus fruits and tomatoes, receiving an average of only 2.8 servings per week per person. Although the consumption of green and yellow vegetables was higher for the control group than for the deviant group it could not be considered generous in either case.

Among the girls the control group consumed greater amounts of green and yellow vegetables, citrus fruits and tomatoes and whole grain products and less milk and sweets than did the deviant group. The girls in subgroup GD- were the ones who consumed the larger amounts of milk and since they are the girls who tend to be underweight for their age and height they may have increased their intake of milk in an effort to gain weight. The intake of whole grain products for this group was also considerably greater than that for the subgroup GD+. The rather high consumption of sweets by the subgroup GD+ may have been a contributing factor in their overweight condition.

When those individuals whose diets apparently were lacking in one or more food groups were questioned regarding the regularity with which they received these foods, it became apparent that the majority of the subjects did not receive the specific foods any oftener, if as often as indicated by the three-day food record. This fact might indicate also that the diet records as submitted by the students were inclined to present a better picture of their diet patterns than might actually exist. On the other hand,

most of the students reported eating green and yellow vegetables and tomatoes regularly in the summer but very few seemed to be receiving them during the winter months.

The girls tended to consume more citrus fruits and green and yellow vegetables than did the boys who were more inclined to eat greater amounts of whole grain products, meat, fish and poultry, and sweets. The two subgroups BD+ and GD+ which are composed of the students who are larger than the average for their own age and sex and, in many cases, overweight, consumed more sweets, citrus fruits and green and yellow vegetables than did the corresponding groups BD- and GD-. These latter groups drank more milk than did the former ones.

Nine of the forty students studied were taking vitamin supplements. In 66 percent of the cases where supplementation was received the dietary intake of the individual was sufficient to meet the full recommended allowance. If the recorded intake can be considered indicative of the usual diet pattern it would appear that much of the supplementation was unnecessary. However, the fact that five of these nine students were from a control group and exhibited a characteristically regular growth pattern might indicate that this supplementation of the diet; if it had been practiced over a considerable period of time, may have been a contributing factor in promoting rhythmic growth and development.

During the original survey, recommendations for the improvement of dietary habits were made to twenty-five of the students participating in the present study. These

recommendations made by the nutritionist were based on the one-day diet record and thus are not directly comparable to findings of the present study. However, it was found that there was an improvement in the intake in forty per cent of these cases in that an amount of food fully meeting the recommended allowance for the nutrient concerned was ingested according to the three-day record. There is a possibility that this improvement was the result of the recommendations made to the student by the nutritionist but since the methods of analyses varied a direct comparison is not justified. The analysis of the three-day records also indicated rather severe dietary inadequacies especially in the intake of calcium, vitamin A and vitamin C, which were not evident from the one day record. An increased consumption of green and yellow vegetables, citrus fruits or milk by the individuals concerned would help improve the situation.

The DMF for boys showed no appreciable difference between the control and the deviant groups. However, the ratio of decayed to filled teeth was approximately 1:2 for the deviant group and 1:4 for the control group. This fact indicates that the control group are receiving more adequate dental care than are the deviant group. The CAMF showed more pronounced evidence of this.

Among the girls the deviant group had a considerably higher DMF than did the control group and exhibited a similarly lower ratio of decayed to filled teeth as was noted among the boys. The use of the CAMF revealed a ratio of 1:4 between the number of cavities and the number

of fillings for both groups.

The oral hygiene of the girls was assessed as being better than that of the boys but the DMF of the girls indicated that their teeth were more susceptible to caries.

A comparison between the negatively and the positively deviating groups of both boys and girls showed that the negatively deviating groups had higher values of DMF than did the positively deviating groups. This observation does not appear to support the finding of Dreizen et al (52) that malnourished children have an incidence of caries only 44.5 per cent of that group of well nourished children.

In comparing the dental data from the present study with those from studies on similar age and sex groups in other parts of the country it is seen that the rate of dental decay among the students of the Holland High School is considerably higher than that for other areas of the country. An explanation of this situation is not apparent although a positive correlation was found between the intake of sweets and the DMF ($r = 0.32$ with 38 degrees of freedom). This result is significant in 19 cases out of 20 (73) which indicates that a high incidence of dental caries may be associated with a high intake of sweets. No significant correlation was found between DMF or CAMF and the total caloric intake, total carbohydrate intake, ascorbic acid intake or calcium intake. An analysis of the fluorine content of the water used in the area was not available. It does not seem probable that the high incidence of dental caries experience found in this community could be attrib-

uted to the fact that they are a group of predominantly Dutch descent since it has been shown that the children in Holland have a DMF considerably below the average for the same age group in the United States (57).

There was a total of 41 missing teeth reported. Of these twenty-five or 61 per cent were six year molars. This finding is in agreement with that of other investigators (58, 59). This situation may possibly be due to a lack of dental care at the time when the six year molars are first erupting since a great many parents fail to realize that these are permanent teeth which need adequate dental attention in order to be preserved. The tendency to neglect the deciduous teeth on the grounds that the children are going to lose them eventually is common among families in the area under consideration. A greater degree of dental neglect was evident among the boys than among the girls as indicated by the total number of cavities present at the time of the study.

The fact that the majority of the students reported having been under the care of the dentist within six months previous to the present examination and stated that they were in the habit of visiting the dentist at regular intervals would indicate that either all necessary repair work was not being taken care of at the time of the dental visit or that the rate of decay was very rapid among students of high school age. Although a determination of the yearly increments in carious surfaces was impossible under the conditions of the study, the report of the number

of cavities present would indicate a much more rapid rate of tooth decay than that of 1.8 tooth surfaces per year as reported by Klein and Palmer. (50)

A correlation of the plasma protein levels as determined during the original survey with the intake of protein as indicated by the three-day record indicated that there was no significant relationship between the two. However, the average daily individual intake of protein ranged from 58.2 grams to 175.5 grams which is equivalent to at least one gram per kilogram of body weight and should be sufficient to supply the needs of the body tissues. Hence one would not expect to find any clinical signs of protein deficiency among the group studied or a corresponding rise in serum protein with an increase intake. The plasma protein levels varied over a comparatively narrow range of 6.5 to 8.4 grams per 100 cubic centimeters of blood when compared to the wide range of intake.

A positive and significant correlation was obtained between the blood levels of vitamin C and the dietary intake of the vitamin although the two measurements were made three months apart. A correlation coefficient of 0.48 with 36 degrees of freedom was obtained which indicates that in ninety-nine cases out of one hundred the blood value would be directly related to the dietary practices. No significant correlation was found between the levels of vitamin A or carotene in the blood and the dietary intake of vitamin A.

Since serum phosphatase values have been shown to decrease with age from childhood to adulthood, it is difficult to explain values of 12 Bodansky Units which were reported for some individuals. It is known that one student whose blood phosphatase was 15.3 Bodansky Units had experienced a recent growth spurt. Also, the fact that considerably higher serum phosphatase levels were found among the boys than among the girls may indicate that such values are related to physiological maturity. Since it is known that boys reach pubescence approximately two years later than girls it is quite probable that the phosphatase content of the blood of the boys of the age studied was stimulated by the fact that they were in the period of rapid adolescent growth. Further evidence of the relationship of phosphatase content to maturity is the fact that of the six girls who had comparatively high values, five had not begun to menstuate until after 14 years of age and were characteristically small. If phosphatase values can be shown to parallel physiological age, then it would appear that the deviant group of boys was slower in maturing than was the control group. Among the girls the highest phosphatase values were found for those individuals who had not begun to menstruate until a later age.

When the available height and weight measurements were plotted on the Wetzel Grid it was evident that the growth pattern of individuals in the control groups tended to follow a uniform course and the limits of variation for

the whole group were comparatively narrow. The deviant groups followed a much more erratic pattern of growth and the variation between the performance of individuals was much greater. These facts indicate that those individuals who were chosen as representative of their own age and sex group had followed a fairly consistent growth pattern throughout their lives. In cases where marked deviations from the regular growth channel were noted a check was made with the report of past medical history in an attempt to determine the cause of the deviation. In most cases where an individual's status fell to a lower physique channel, the time of such a divergence followed such abnormal conditions as scarlet fever, rheumatic fever or tonsillitis or long periods of confinement in bed. In some instances an improvement in the channel position of the individual was found to follow a tonsillectomy. The effect of the time of the year when measurements were made could not be illustrated.

If the single measure, regularity of growth, is used as a criterion for the selection of students from the original group, essentially the same classification of individuals results as if all the criteria - hemoglobin, plasma proteins, cell volume and height and weight - had been used. This observation might justify the assumption that children who deviate markedly from the growth pattern for their own age and sex show some evidence of nutritional instability. The observation that nutritional stability and regularity of growth tend to parallel each

other is comparable to the findings of Stearns (79) who in her work on the feeding of babies found that a much more regular pattern and higher level of growth was obtained when the babies received optimal rather than suboptimal or excessive amounts of the cod liver oil supplement and that the limits of variation within the group were much narrower.

A hemoglobin content of 12.3 grams per 100 ml. of blood for all the girls and 14.3 grams for all the boys was found as a result of the three individual determinations. Since hemoglobin value was one of the criteria used in the original selection of the students it would be expected that the positively deviating group would have an average hemoglobin value greater than the average for their own sex whereas the negatively deviating groups would have an average hemoglobin content below the average for their own group. The fact that the same trend is followed by the group whether either a single value or an average of three determinations is used as a basis for judgment indicates that hemoglobin levels follow a somewhat consistent pattern. Although high hemoglobin values are usually considered desirable the fact that the positively deviating groups did have very high values and also showed evidence of definite health problems raises the question as to whether high levels can also be considered optimal levels. The individuals with very high hemoglobin content showed as much evidence of nutritional instability as did those with very low content.

The averages of the three determinations for each individual as compared to the single hemoglobin value obtained during the original survey are consistently lower. The wide range between the minimum and maximum values obtained for some individuals is indicative of the erroneous evidence as to hemoglobin status which could result from the use of a single determination. The fact that all the measurements on one individual were made at approximately the same time of day in the majority of the cases studied and that a wide discrepency was still found leads one to question the validity of presenting the average of the three determinations, instead of the range of values determined.

A decrease in the hemoglobin levels in the period between the original survey and the present one was noted for several individuals. In the cases of two of the girls this drop could be attributed to the fact that they began to menstruate during this period. No reason was apparent for the other decreases noted. The fact that the original figure was based on one determination while the present one is an average of three figures does not allow one to place too much significance on the apparently lower levels.

The average age for the onset of menstruation was 1.3 years later for the girls in the deviant group than for those in the control group and within the deviant group the girls who were chosen because their measurements deviated in a positive direction from the average for their own group began to menstruate 2.2 years earlier than the girls whose measurements deviated on the negative side of their own

group average. If the age of onset of menstruation can be considered indicative of physiological maturity it would appear that the girls in the control group had matured at an earlier age than those in the deviant group, and also that the larger girls tended to mature much earlier than the smaller ones. This difference in maturity is also indicated by the higher phosphatase values recorded for the negatively deviating group. The average age for the onset of menstruation of 12.4 years for the control group and 13.6 years for the deviant group is in accord with the average age of 12.9$\pm$ 1 years reported by Leichsenring et al (68) as a result of a study on 258 high school girls. The negatively deviating group with a menstrual age of 14.5 years is slower in reaching maturity than would be expected. The role of nutritional factors in this apparently retarded maturity is not evident.

The complete physical examination failed to reveal any abnormalities which had not been recorded either in the original survey or in the medical history or interview. The fact that over 50 per cent of the students originally surveyed were found to have enlarged thyroids while only two cases were reported in the more extensive examination might indicate that the standards of normalcy varied with the two physicians making the examinations.

The boys in the control group came from homes in which there were more rooms per person than there were in the homes of the members of the other three groups. These boys were also members of smaller families which might

indicate that they had received more individual attention during their growing years and that a larger share of the family income had been devoted to their welfare than if there had been more children to share it. The boys in the control group worked for an average of 15.1 hours per week after school for pay and this is over twice the average length of time worked by members of any other group. Since those who worked the most came from smaller families living in larger homes it does not seem likely that it was necessary for them to obtain employment for economic reasons. The question then arises as to whether the deviant group were unable for physical reasons to undertake as much extra-curricular work.

The fact that the girls did not work as much as the boys may indicate that they had less opportunity to obtain employment or it may reflect a cultural pattern of the community requiring that the boys learn to support themselves at an early age while family pride would keep the girls from becoming economically independent.

The average grade in school which was completed by the parents of the students participating was considered indicative of their educational attainments and was found to be essentially the same for all groups except the deviant group of boys whose parents had a slightly lower educational level. However, in the case of the education of the older brothers and sisters of the participants, those of the control groups advanced considerably further in school than did those of members of the deviant groups. These facts

indicate a higher educational level among the families of the control groups than among those of the deviant groups which might be a contributing factor in determining the dietary habits of the family.

From the record of the number of meals which the students ate outside of the home each week it is evident that the deviant groups receive fewer meals at home per week than do the control groups, there being greater difference among the boys. This fact may be an influencing factor in determining the individual's diet pattern. From observations made in the school cafeteria it is evident that those who eat their mid-day meal there receive an adequate and well-balanced lunch which is as good as, if not better than, that which they would receive at home. However, it is the students who eat their lunches at restaurants and hamburger stands who showed very poor judgment in their choice of meals. A typical lunch among this group consisted of hamburgers and coca-cola. The consumption of soft drinks and candy is essentially the same for the deviant and the control groups.

The data on childhood diseases contracted by the individuals indicates an essentially equal susceptibility among members of all groups. The only instance in which an appreciable difference was noted was tonsillitis among girls, the deviant group having eight members who had had cases whereas the control group had had only two. Of the three relatively mild communicable diseases - chicken pox, mumps and measles - each child averaged 2.4 cases. One fifth of

the forty students had had scarlet fever, one half whooping cough and 19 of them reported having frequent colds.

EVALUATION

From a public health standpoint the value of a nutritional survey lies in its ability to present a general assessment of the nutritional status of a community and also to select those individuals who have definite health problems. If local and state health authorities are going to be able to utilize nutritional surveys to increase the efficiency of their public health nutrition programs the number of individual tests employed in conducting the survey must be reduced to a minimum. The tests selected should be relatively routine in nature, should not require the services of highly trained personnel and should be adequate to select those members of the population who require special Public Health care.

Once obtained it is necessary to compare a series of measurements to accepted standards of normalcy based on a similar group in order to select cases in which abnormalities may be indicated. Since no standards based on a group similar to the one studied in the Holland High School were available, a range of values calculated from the mean measurement for each age and sex group plus and minus one and one half the standard deviation of the mean was arbitrarily chosen as indicative of normalcy in regard to that one measurement. Since this range of values includes 86% per

cent of the measurements for the entire group, it can be used in the selection of the 14 per cent whose measurements deviate most markedly from the mean. It is in a group whose measurements fall outside the suggested range in regard to two or three criteria that one would expect to find the majority of individuals who have real health problems if the tests used can be considered adequate for screening purposes. It is also necessary that the group whose measurements correspond most closely to the mean measurements for their own group be relatively free from health problems.

A reclassification of the participants of this study on the basis of the more extensive data, showed that 80 per cent of the girls and 70 per cent of the boys originally selected for the deviant group would be considered as having nutritional or health problems whereas only 20 per cent of the girls and 30 per cent of the boys in the control groups showed evidence of nutritional instability. However, when one considers the original tests individually it becomes evident that all but one of the students reclassified as having health problems would have been chosen had the single measurement, height-weight ratio and a range of plus or minus one standard deviation, been used as a basis for selection.

Moreover when one considers growth as measured in height and weight over a number of years, and plots the data on the Wetzel Grid it is found that the student who shows evidence of having health problems is usually the one who has exhibited an erratic pattern of growth throughout

childhood and adolescence. These divergences in the direction of growth can often be traced to certain periods of illness. In view of this observation, it would seem desirable to recommend that local health departments establish a program of regular height and weight measurements on all school children. These measurements could be charted readily on a Wetzel Grid, such a grid to remain with the child's records as he progresses through school. Whenever a child's growth pattern tends to change physique channels away from the central channels A_1 - B_1 towards the extreme channels A4 - B4 further investigation in the form of a physical examination, a dietary history and blood analysis would be indicated. In this way the cause of the deviation could likely be determined and corrective measures applied before the trend continued.

These observations from height and weight data alone would indicate that they provide sufficient basis for the screening of an adolescent group. The dietary data, physical examination and biochemical determinations on the blood provide valuable confirming information but are unnecessary in the original survey. This finding substantiates somewhat the finding of Cicocco et al[74] who studied the height-weight data on a group of children and then the Selective Service classification of these same subjects some 15 years later. The underweight children had grown into a group with a higher percentage of persons with physical defects than of persons classified as acceptable by Selective Service standards. The reverse was true of

children above the middle-weight range.

The outstanding health problem noted among the Holland High School students which could possibly be related to nutrition was the very high incidence of dental caries. Since considerable controversy exists as to the cause of dental caries much more extensive investigations would be necessary in order to determine the causative factor or factors in this area where the incidence of dental caries experience is so much higher than in other areas. It is an accepted fact that there is an insufficient number of dentists to care for the needs of the community and this may account for the high incidence of unfilled cavities noted. However the inadequacy of dental services does not account for the originally high incidence of dental caries.

Although the high incidence of enlarged thyroids reported in the original survey was not reported by the local physician examining the same group, it is highly probable that different standards of judgments were used in the two cases. It may be that the condition is so prevalent in the area, that only a person who had not been living in the community would consider the mild cases worthy of attention. Regardless of the reason for the differences in the two reports, the fact that there is a tendency towards enlarged thyroids would warrant the revival of an educational program on the use of iodized salt. In a discussion with a group of comparatively well-educated individuals, it became evident that many people were unaware of the fact that not all salt on the market was iodized.

The dietary data obtained from the school children indicated a need for increased consumption of green and yellow vegetables and citrus fruits especially during the winter months. It is recognized that the economic factor is probably the determining one in this situation. However the fact that approximately 50 per cent of the students were reported during the original survey to have follicular conjunctiva, which is considered a manifestation of vitamin A deficiency indicates the need for an increased consumption of vitamin A rich foods regardless of the cost. The absence of any measurable source of vitamin D in the diets examined although not necessarily indicative of an inadequacy of this nutrient, suggests a need for further investigation of the problem.

SUMMARY AND CONCLUSIONS

1. Forty high school students chosen on the basis of data obtained by the U. S. Public Health Service in a survey of a larger number of students have been studied. The information obtained included reports of dental and physical examination, blood analyses, height and weight measurements, diet records and evidence of socio-economic status.

2. A reclassification of the students studied indicates that successive height and weight measurements, if properly treated provide sufficient basis for the selection from a group of adolescents of those individuals showing signs of nutritional instability. If these measurements, which can be made readily by any school teacher, were made at regular intervals and plotted against a suitable standard they would provide a visible pattern of the student's growth.

3. The incidence of dental caries was found to be very high among the group studied. Some correlation ($r = 0.32$) was found between the intake of sweets and the DMF. Since the diets contained no measurable source of vitamin D and the intakes of vitamin A and vitamin C were irregular, the possibility of a relationship between these dietary factors and dental caries experience might bear investigation.

4. Evidence is presented which indicates a positive relationship between serum phosphatase and physiological maturity or rate of growth.

5. The desirability of very high hemoglobin values is questioned in that those individuals exhibiting the highest values were among the ones showing evidence of having definite health problems.

6. Probable dietary inadequacies were found most often in respect to vitamin A and vitamin C, the intakes of which are especially low during the winter. The adequacy of vitamin D nutrition in the group is questioned. The tendency towards enlarged thyroids among the high school students is evidence of a possible iodine deficiency.

7. A highly significant correlation was found between plasma ascorbic acid concentration and the dietary intake of that nutrient. The value of the additional information provided by the biochemical analyses of the blood-plasma protein, cell volume hemoglobin, vitamin A, carotene, ascorbic acid and phosphatase does not appear to warrant their use in a survey of a group similar to the one studied where the majority of the individuals are relatively well nourished.

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APPENDIX

GENERAL QUESTIONNAIRE

Name_____Date_____

Address_____

Birth date_____Age_____Sex_____

Place of birth_____

Nationality_____Are you a citizen of the U.S.?_____

Father's birthplace_____

Mother's birthplace_____

How many generations has your family lived in the U.S.?_____

How many members are there in your family?_____

Father_____

Mother_____

Brothers_____Younger?_____Older?_____

Sisters_____Younger?_____Older?_____

Are all members of your family living?_____

If not, give cause of death_____age at death___relation_____

_____ ____ _____

_____ ____ _____

What is your father's occupation?_____

Is he employed now?_____Where?_____

Are other members of your family employed?_____

If so, give details._____

	Occupation	Full time	Part time
Mother	_____	_____	_____
Brothers	_____	_____	_____
Sisters	_____	_____	_____
Self	_____	_____	_____

Father's education: Grade completed____College___Degree_____

Mother's education: Grade completed____College___Degree_____

How long has your family lived in this community?_____

Where did they live before?_____How long?_____

How many rooms are there in your home?_____

Does your family own your home?_____Rent it?_____

Approximate rent_____
(below $30., $30-$60, over $60.)

Do you eat all your meals at home?_____

If not, where do you eat them?_____

If not, how often do you eat out?_____

Do you have at least one hot meal daily?_____

Do you eat your lunch at home?____School cafeteria?_____

Elsewhere?_____carry it?_____

What is the average cost of this meal?_____

Do you eat between meal snacks?___often?___Seldom?__Regularly?

Do you eat at bedtime?_____often?___Seldom?__Regularly?

Does your home have electricity?_____

running water?_____

Does your family have an automobile?_____

radio?_____

refrigerator_____Mechanical_____ice_____

How many hours of sleep do you get?_____

At what time do you usually get up?_____

go to bed?_____

How do you spend your summer vacation: at home? _____camp?

___working?_____otherwise?_____

If working, where do your work and what kind of work do you do?_____

_____

Do you work for pay during the school year?__after school?____

Week ends?_____What do you do?_____

Do you participate in sports: actively?__occasionally?_____

never?_____

What sports do you particularly like?_____

How many times per week do you have ice cream_____

candy_____

gum_____

soft drinks_____

tea, coffee_____

Do you take vitamin preparations?_____What kind?_____

Do you take cod liver oil?_____What kind?_____

How many glasses of milk do you drink daily?_____

How many glasses of water do you drink daily?_____

MEDICAL HISTORY

Name

Check once the conditions which you have had and give approximate dates Check twice those you now have.

Acne	Jaundice
Bronchitis	Rheumatism
Chickenpox	Tonsillitis
Measles	Colds, frequent
Whooping Cough	Pneumonia
Diarrhea	Migraine headaches
Diphtheria	Infantile Paralysis
Scarlet Fever	Smallpox
Tuberculosis	Appendcitis
Typhoid fever	Mumps
Malaria	

Have you ever had any surgical operations?_____
Explain_____

Have you ever had any broken bones?_____
Explain_____

Have you ever been confined to bed for a long period of time__

If so, why and how long?_____

Who is your family doctor?_____

dentist?_____

When did you last see a dentist?_____

When were you last under the care of a doctor?_____

Is any member of your family now under doctor's care?_____

Why?_____

Do you ever have: How often?

Loss of appetite	Shortness of breath
Nausea or vomiting	Swellings
Cramps	Boils
Chest pain	

Have you been protected against

Small pox_____

Typhoid_____

Diphtheria_____

Whooping cough_____

Other_____

Give dates.

Have your parents or any brother or sister or any relative ever had:

Tuberculosis_____

Insanity_____

Epilepsy_____

Gout_____

Diabetes_____

Cancer_____

Heart Disease_____

For girls:

When did you start to menstruate?_____

Is menstruation regular?_____

Approximate intervals between periods?_____

Is there pain?_____

Degree: mild, no bed rest; bed rest 3 - 6 hours; bed rest 1 day or more; acute with vomiting.

PHYSICAL EXAMINATION

Name _____ Age _____

Address _____ Date _____

Appearance _____

Obese _____ Normal _____ Undernourished _____

Marked _____ Marked _____

Moderate _____ Moderate _____

Body build

Stocky _____ Average _____ Slender _____

Color Good _____ Slight pallor _____ Moderate to marked pallor _____

Skin: Clear _____ Not clear, explain _____

Other (dry, moist, soft, lost weight) _____

Eyes: Lids: Normal _____ Blepharitis _____

Conjunctiva: Normal _____ Conjunctivitis _____

Pupils: Normal _____ Abnormal _____

Vision: Without glasses R. _____ With glasses R. _____
L. _____ L. _____

Ears: _____

Right: Normal ___ Discharge ___ Wax ___ Hearing _____

Left: Normal ___ Discharge ___ Wax ___ Hearing _____

Nose: Discharge: None _____ Mucus _____ Pus _____

Obstruction: None _____ Mucus _____ Pus _____

Other abnormalities: None _____ Present _____

Explain: _____

_____

Mouth: Tongue: Normal _____ abnormal _____

Mucus membranes: Normal _____ Abnormal _____ Explain _____

_____

Throat:

Tonsils: normal_____

enlarged: Moderately_____marked_____

removed_____

Neck: _____

Thyroid: Normal____enlarged: Slight___Moderate_____ marked____

Lymph nodes: Enlargement: slightly___moderate__marked____

Other abnormalities:_____

_____

Chest:_____

Slope: normal_____abnormal findings_____

_____

Lungs: normal_____abnormal findings_____

_____

Heart: normal_____ Murmur_____

Other abnormalities: none____present_____

Explain:_____

_____

Abdomen: Normal_____
Abnormal findings:_____

_____

Extremities: Normal____Abnormality, location and description (arms & legs)

_____

Paralysis: none___present, explain_____

_____

Feet: Normal_____Flat feet_____

Spine: Normal_____

Kyphosis: Moderate_____Marked_____

Lordosis: Moderate_____Marked_____

Scaliosis: Moderate_____Marked_____

Reflexes: _____

Knee jerk_____

Elbow_____

Remarks:

RECORD OF MEALS FOR ONE DAY

Name_____ Date_____

DIRECTIONS:
List all the foods that you have eaten in the last 24 hours, including butter and beverages.
Tell whether food was raw or cooked, and if cooked tell how, as raw apple or baked apple.
Tell whether bread was made of corn, rye, whole wheat or white flour, as corn muffins.
If you ate 2 helpings of a food write after it (2); if 3 helpings, write (3).

FOODS EATEN FOR BREAKFAST

1._____ 4._____ 7._____

2._____ 5._____ 8._____

3._____ 6._____ 9._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink between breakfast & noon?_____

FOODS EATEN AT NOON

1._____ 4._____ 7._____

2._____ 5._____ 8._____

3._____ 6._____ 9._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink between the noon and evening meal?_____

_____

FOODS EATEN AT EVENING MEAL

1._____ 5._____ 9._____

2._____ 6._____ 10._____

3._____ 7._____ 11._____

4._____ 8._____ 12._____

What foods were on the table that you did not eat?_____

What foods did you eat or drink before you went to bed?_____

_____

FILE NO._____

CHILDREN'S FUND OF MICHIGAN

DENTAL CLINIC RECORD

CARD NO._____

NAME_____ SCHOOL_____

ADDRESS_____ DATE OF BIRTH_____

PROGRESSIVE EXAMINATION RECORD

DATE OF EXAMINATION		1ST	2ND	3RD	4TH
REQUIRES DENTAL TREATMENT OTHER THAN PROPHYLAXIS?	YES				
	NO				
MOUTH HYGIENE	GOOD				
	FAIR				
	POOR				
NUMBER OF CAVITIES	DECID.				
	PERM.				
NUMBER OF ABSCESSES	DECID.				
	PERM.				
REMARKS					
ALL CORRECTIONS COMPLETED BY (GIVE DATE)	FAMILY DENT.				
	CLINIC DENT.				

TO RECORD EXAMINATION

- X { UNERUPTED / EXTRACTED / MISSING
- V CAVITY
- = RECURRENT DECAY
- ? QUESTIONABLE
- A ABSCESSED
- R ROOTS ONLY REMAIN
- // ACCEPTABLE FILLING
- // ACCEPTABLE CROWN
- II ROOT CANALS FILLED

TEETH NOT MARKED ARE O K

TO RECORD OPERATIVE WORK

- X EXTRACTED
- √X FILLING PLACED
- II ROOT CANALS FILLED

TO RECORD EXAMINATION RECORD / OPERATIVE RECORD

- 1ST USE BLACK INK
- 2ND USE RED INK
- 3RD USE GREEN INK
- 4TH USE BLUE INK

C.F.M. FORM 2-615

EXAMINATION RECORD

OPERATIVE RECORD