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Anthropometry, Metabolic Control and Dietary Intake of Youth with Insulin-Dependent Diabetes Mellitus

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ANTHROPOMETRY, METABOLIC CONTROL AND DIETARY INTAKE OF YOUTH WITH INSULIN-DEPENDENT DIABETES MELLITUS

by

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Shelly Clark

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ABSTRACT

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Intake of Youth with Insulin Dependent

Diabetes Mellitus

by

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The purpose of this study was to describe a sample of insulin-dependent diabetic youth in terms of selected anthropometric measurements, level of metabolic control and dietary intake. The 22 subjects (10 males and 12 females) were between the ages of seven to 16 years and, except for one female, regularly attended a multidisciplinary outpatient diabetes clinic.

The study involved cross-sectional observation of height, weight, triceps and subscapular skinfold measurements, mid-arm muscle circumference and weight:height ratios, and comparison of these measurements to national norms derived from non-diabetic controls. Levels of metabolic control were observed using glycosylated hemoglobin values, and examined for effect on anthropometric parameters. It was found that the group generally fell within normal distribution patterns for all growth parameters when compared to control data. Level of metabolic control, duration of diabetes and age at onset of disease had no significant effect on the anthropometric parameters studied. Duration of diabetes had no effect on level of metabolic control.

The study group consumed most nutrients in amounts consistent with the 1980 Recommended Dietary Allowances, with the exception of vitamin B_6, folacin, iron and zinc. Consumption of total fat, saturated fat and cholesterol were in excess of the current recommendations for diet in diabetes, and proportion of total energy from carbohydrate tended to be lower than recommended. Mean intakes of vitamins A, C, B_6 and B_{12}, thiamin, riboflavin, niacin, calcium, phosphorous, iron, magnesium and protein appeared to be higher than mean intakes of the same nutrients reported from the Nationwide Food Consumption Survey (1977-78) and the Second National Health and Nutrition Examination Survey (1976-80) for corresponding age groups. It was suggested that since young diabetic individuals usually have close supervision of their dietary intake, their intakes are somewhat superior nutritionally than those of non-diabetic individuals.

The study sample reported use of a number of special dietetic foods other than dietetic soda and sucrose-substitutes. Foods used for treatment of hypoglycemic reactions included candy, fruit and juices, regular pop, frosting and special glucose preparations designed specifically for use with insulin-dependent diabetes.

(196 pages)

CHAPTER I

STATEMENT OF THESIS PROBLEM

Introduction and Background of the Problem

Diabetes mellitus is a metabolic disorder which, in the past, was considered to be a single disease. Recent investigations into the epidemiology, genetics, etiology and pathogenesis of diabetes have shown that it is not a single disease entity but rather "a clinical syndrome characterized by inappropriately elevated fasting and/or postprandial blood glucoses" (Lebovitz, 1984, page 521). Insulin-dependent diabetes mellitus (IDDM or Type I) and non-insulin-dependent diabetes mellitus (NIDDM or Type II) comprise the majority of the idiopathic diabetes population. People with IDDM represent 5 to 10 percent of the total diabetic population and those with NIDDM approximately 85 to 90 percent (Drash, 1983; Lebovitz, 1984). The distinguishing feature between the two disorders is that IDDM is characterized by complete insulin deficiency, and thus, an exogenous source of insulin becomes essential to prevent ketoacidosis and death.

IDDM generally occurs in children and adults less than 40 years of age. It has been estimated to affect 1.6 per 1,000 school-age Americans (Bacon et al., 1982). Although NIDDM affects more females than males, IDDM occurs with comparable frequency in both sexes (Drash, 1983). Japanese and American Black populations appear to have lower incidences of IDDM than do Caucasians (Lebovitz, 1984).

The etiology of IDDM is multifactorial. Genetic factors, in combination with various environmental factors including viral infections and/or chemical agents, are associated with onset of the disease. The manner in which these factors contribute to onset of IDDM remains unclear, but the resultant destruction of the pancreatic islet cells appears to be autoimmune in nature (Drash, 1983; Bacon et al., 1982).

The complications of IDDM include neuropathy, retinopathy, nephropathy, and can lead to blindness, physical impairment due to loss of function of the extremities, and death. Emotional stress associated with diabetes may also affect quality of life for the individual and the immediate family (Anderson et al., 1981; Ahlfield et al., 1983).

Treatment of IDDM involves three aspects of care: insulin, diet and exercise. Physicians, nurses, dietitians and social workers all play vital roles in the physical, nutritional and psychosocial assessment and care of the diabetic patient (Bacon et al., 1982). Education of the patient and family cannot be overemphasized, particularly regarding integration of the three components of care. Thus, the team approach is most beneficial. "Meticulous control can be achieved only by informed patients cooperating with health professionals in a planned system of health care..." (Etzwiler, 1983, page 639). A solid foundation of knowledge must be established at the time of diagnosis and continuing educational opportunities must be available if long-term management of IDDM is to be successful.

Evaluation of glycemic control has been done using urine testing for glucose and ketones, spontaneous blood glucose determination and, most recently, glycosylated hemoglobin values. The advantage of glycosylated hemoglobin values over spontaneous blood and urine testing is it provides a picture of chronic glucose levels that is relatively independent of transient fluctuations in blood glucose concentrations (Nathan, 1983).

Poor metabolic control can result in delayed and/or stunted growth (Spencer, 1928; Boyd and Kantrow, 1928; Jackson and Kelly, 1946; Birkbeck, 1972; Jackson et al., 1978; Edelsten et al., 1981; Mella, 1981). Sub-optimal growth patterns have been associated with age of onset, and with longer duration of the disease (Evans and Lister, 1970; Jivani and Rayner, 1973; Van Dyke et al., 1973). The appearance of growth disturbances has been attributed to factors ranging from inadequate nutrition (Jackson and Kelly, 1946; Bergqvist, 1954) to "unphysiological" levels of insulin (Birkbeck, 1972) which would result in altered levels of the growth mediators somatomedin and growth hormone. Resistance to growth hormone has also been proposed as a cause of growth retardation (Horner et al., 1981; Rudolf et al., 1982).

Recommendations for diet in IDDM have ranged from severely restricted (Thompson, 1896, Wood and Bierman, 1972) to the free or unrestricted regimens (Jacobi, 1954). Research areas currently being investigated include the effect of different types of dietary fiber on glycemic response, as well as development of the glycemic index of foods (Jenkins et al., 1981; Jenkins, 1982; Crapo, 1983). The prime objectives of current dietary management include consistency with regard to timing of meals and amounts of food consumed. The individual with diabetes should be taught to make dietary changes to compensate for exercise, hypoglycemic episodes and periods of illness. Attempts should be made to make the diet pattern as flexible as possible. Compliance, which has been reported to be poor (West, 1973) is most likely when a diet pattern most closely resembles a patient's usual dietary habits. Use of pre-made diet handouts is discouraged (Nuttall, 1983). The use of special foods and sugar substitutes is also not condoned, and more research is needed to determine the safety of long term use of these products (Talbot and Fisher, 1978). Although there is substantial literature dealing with recommendations for diet in diabetes, there is little to be found in recent literature with regard to what people with IDDM actually consume.

Statement of the Problem

In spite of recent technological advances in the area of diabetes treatment, little is known about the complex interaction of physiologic changes that are characterized by IDDM. Although growth retardation does not, at present, appear to occur to the degree that it had before the availability of purified and refined insulins, it still occurs, especially when subjects are in lower levels of metabolic control.

Diet has long been considered to be the cornerstone of diabetes care. Even though knowledge has increased greatly about the medical aspects of diabetes care, very little is actually known about the ideal dietary prescription for individuals with diabetes.

Reports of growth status and dietary intake patterns of youth with IDDM are few, especially since the advent of current modern treatment practices (intensive insulin therapy using purified insulins and home blood glucose monitoring techniques). An investigation and description of these aspects of IDDM in youth should provide valuable information.

Purpose

The purpose of this study was to describe a sample of 22 youth with IDDM in terms of selected anthropometric measurements, dietary intake, and metabolic control as determined by glycosylated hemoglobin values. Statistical methods were utilized to determine if relationships existed between growth parameters and level of metabolic control, duration of diabetes and age of disease onset.

Anthropometric measurements included height, weight, subscapular and triceps skinfolds, and mid-arm muscle circumference. These measurements were expressed as percentiles for age and sex for each subject using percentile values from the National Center for Health Statistics (1972; 1975; 1977) and upper limb fat and muscle area norms published by Frisancho (1981).

Dietary intake data from 3-day diet records were analyzed using a computerized nutrient analysis program. Composition of the diet was described in terms of total calories, carbohydrate, protein, fat, added sugar, vitamins and minerals. Data were compared to the

American Diabetes Association's 1979 recommendations for diet in diabetes, to Recommended Dietary Allowances (1980) for age and sex, and to dietary survey data from the United States Department of Agriculture's Nationwide Food Consumption Survey (USDA NFCS) of 1977-78 and the Second National Health and Nutrition Examination Survey II (NHANES II) of 1976-80.

Objectives

Objective I

To examine anthropometry (height, weight, triceps skinfold, mid-arm muscle circumference and subscapular skinfold measurements) of 7 to 16 year old youth with IDDM, and to compare these parameters to the National Center for Health Statistics Standards (1972; 1974; 1977) and upper limb fat and muscle area norms published by Frisancho (1981).

Objective II

To determine the duration of diabetes using both medical record information and subjective questionnaire responses.

Objective III

To determine the level of metabolic control for each subject, for the entire group and for males and females separately, using glycosylated hemoglobin values.

Objective IV

To compare mean glycosylated hemoglobin values of males to mean values of females, controlling for age.

Objective VI

To examine the effect of:

A. duration of diabetes on level of metabolic control,

B. age at onset on level of metabolic control,

C. duration of diabetes and age at onset on growth parameters

D. age at onset on growth parameters, and

E. metabolic control on growth parameters.

Objective V

To describe dietary intake patterns of subjects with IDDM:

A. analyze and average 3-day food intake records using a computerized nutrient analysis program;

B. compare nutrient intake data with:

   1. 1980 RDA for age and sex,

   2. the 1979 American Diabetes Association recommendations for diet in diabetes,

   3. survey information for the same age groups from the Nationwide Food Consumption Survey (NFCS) 1977-78 (United States Department of Agriculture, 1980), Preliminary Report No. 2 and the Second National Health and Nutrition Examination Survey (NHANES II) 1976-80 (National Center for Health Statistics, 1983);

C. determine magnitude of day-to-day variability for intakes of total calories, carbohydrate, protein and fat, and to determine if a relationship between variability and HbA_{1c} exists;

D. describe the use of dietetic foods and various nutritive and non-nutritive sweeteners.

Limitations

1. Weight was measured in light-weight street clothing, while subjects of the control population were weighed in examination clothing of constant weight. Weights of clothing were not accounted for in either study.

2. A Continental scale with moveable measuring rod was used to measure height. The rod may not remain at a precise right angle and thus, introduce error to the data.

3. Significant measurement errors in weight could have occurred due to variable food, fluid, fecal and urinary status of the subjects.

4. Estimates of muscle size of the upper arm are characterized by an unknown amount of variability since 1) the circumference of muscle does not include bone diameter, and variability in humerous diameter is not accounted for by the MAMC equation; 2) the equation assumes cylindrical form, although the upper arm is not actually cylindrical and 3) skinfold compressibility varies and the MAMC equation does not account for this variability.

5. The state of analytical methodology varies depending on the nutrient. Currently available data may not always reflect actual

nutrient content of foods, especially with regard to vitamins A and B_6, folacin, iron and total protein (Stewart, 1982).

6. Triceps skinfold measurements may have been altered due to hypertrophy or atrophy of tissue at insulin injection sites.

Delimitations

1. An unknown degree of variability was introduced when dietary intake data was coded to foods in the nutrient data base.

2. The data were collected on a small sample size (n=22). A larger sample size would have been more representative of the population of diabetic youth.

3. Significant measurement errors in weight could have occurred due to differences in types of clothing worn by subjects.

4. HbA_{1c} values may have been altered due to aspirin or penicillin use, certain anemias and presence of abnormal hemoglobins and pH disturbances. These factors were not investigated when HbA_{1c} values were used as a measure of diabetes control.

5. Genetic predisposition toward shortness or tallness was not investigated in this study and therefore, could not be considered when interpreting height data.

6. Activity levels were not investigated in this study and therefore, the most accurate prediction of calorie needs could not be made.

Definition of Terms

Insulin-Dependent Diabetes Mellitus (IDDM)

A metabolic disorder generally occurring in people less than 40 years of age. It is characterized by permanent loss of function of the islet cells of the pancreas and a resultant cessation of endogenous insulin secretion. Without an exogenous insulin supply, hyperglycemia occurs, which leads to severe metabolic ketoacidosis, coma and death. Also called Type I diabetes. In the past, this type of diabetes was known as juvenile-onset diabetes mellitus (JODM) or ketosis-prone diabetes.

Glycosylated Hemoglobin

In the presence of hyperglycemia, many body proteins undergo a glycosylation process. The glycosylation of hemoglobin is slow and non-enzymatic. Of three glycosylated hemoglobins (A_{1a}, A_{1b} and A_{1c}) hemoglobin A_{1c} (HbA_{1c}) comprises the greatest fraction and is most reflective of degree of hyperglycemia for a two to three month period of time. It is considered the most objective indicator of chronic diabetes control currently available for use. Though there is no one widely accepted HbA_{1c} value that separates higher levels of control from the lower, it is generally agreed that 10 percent or greater is indicative of chronic hyperglycemia. Levels less than 8 percent, however, are associated with a higher occurrence of symptomatic hypoglycemia and because of this, are generally not considered a reasonable goal for the individual with IDDM.

CHAPTER II

REVIEW OF LITERATURE

The following is an historical review of the literature related to growth, metabolic control and dietary intake of individuals with IDDM. The literature cited in this review is divided into six categories: (1) Growth and Anthropometry; (2) Metabolic Control; (3) Dietary Intake of Individuals with Diabetes; (4) Recommendations for Diet in IDDM; (5) Dietary Adequacy of Youth in the U.S. Population; and (6) Validity of Dietary Survey Methods.

Growth and Anthropometry

During the pre-insulin era, Joslin, Root and White (1925), reported seeing an increase in height in only one in twenty subjects with juvenile diabetes. It was noted that diabetic children were often above normal height at the time of onset of diabetes. The source of the standards for growth for the non-diabetic child was not given. The study involved observation of 302 diabetic children between the years 1898-1925. One hundred and thirty-two children survived as a result of the discovery of insulin. After treatment with insulin began, an increase in height occurred, but was significantly less than that of the non-diabetic child.

Spencer (1928) compared growth patterns of 45 diabetic children to the "average normal" height and weight standards for age of Bowditch, Heuber and Wood. Although the children tended to be tall for age at the time of onset of their diabetes, rate of growth became suboptimal, in spite of insulin therapy. The growth disturbances were attributed to lack of understanding of the rationale for treatment and resultant lack of compliance with therapy.

Boyd and Kantrow (1938) described 10 children of a total of 167 at the University of Iowa who had significant growth retardation, as determined using standards provided by the Iowa Child Welfare Research Station. These standards were felt to be representative of the population of children from which the study group was drawn. With improved compliance with the prescribed insulin and diet patterns, growth status improved in all but two of the children. These two children were thought to have a pituitary deficiency in addition to diabetes mellitus, and one had been small for age since birth. It was concluded that growth disturbances can be prevented or corrected if glycosuria is avoided and adequate nutrition is provided.

Wagner, White and Bogan (1942) studied the physical and metabolic status of 118 diabetic children whose height at the time of the study was four inches, or 10 centimeters, or more, below the average height for age. One measurement of each child was taken and plotted against the Engelbach standard. The subjects' diets were described as "according to the general rules for children," and contained 40 percent of total calories as carbohydrate, 20 percent as protein and 40 percent as fat. Subjects received either regular insulin alone or in combination with protamine zinc insulin, but it was not stated which, or what percentage, of patients received each treatment. Control of diabetes was measured by "per cent control," which was expressed as a percentage of ingested sugar retained in the body. It was concluded that between 5 to 10 percent of the diabetic children under the researchers' observations had height retardation as previously defined. The majority of growth-retarded subjects were 80 to 90 percent of ideal height for age, while a few were 70 to 80 percent of the chosen standard for age. The researchers felt that a factor existed which inhibited normal growth and development of certain, not all, diabetic children. Duration of diabetes and age at onset influenced this factor. Other factors were believed to result in dwarfism, which included primary pituitary disorders, thyroid and gonadal disorders, cardiac, hepatic, intestinal or renal diseases, undernutrition and infectious diseases.

A longitudinal study which was conducted by Jackson and Kelly (1946) involved monitoring height and weight of 120 juvenile diabetics for two to 10 years. Level of metabolic control was determined for each patient based on sugar content of urine and incidence and severity of insulin shock. The 1945 Iowa City Growth Charts were used to evaluate growth patterns of these children because the researchers felt they "approached the optimum for general pediatric practice" (page 317). Rates of growth were classified as: (1) accelerated, where the curve of an individual's growth parameter were more steeply inclined than the curve of the chart for the whole period of observation or for part with the remainder being normal growth; (2) normal, where the curve of a subject's growth parameter paralleled the curve of the chart; (3) less, where the curve of the subject's growth parameter followed a course less steeply inclined than the chart's curve for the entire period of observation or for part with the remaining part normal; and (4) erratic, where the curve of the individual's growth parameter changed its course from a period of accelerated to a period of less than normal growth, or vise versa. Dietary intake for this group of youth was described as "adequate," but intake prior to becoming involved with these researchers' clinic was of questionable adequacy. It was concluded that this population tended more toward normal or accelerated growth than retarded growth patterns. Children in good-to-excellent diabetes control had a better chance to accelerate than those under lower levels of control. Children in fair or poor diabetic control did not accelerate. Erratic growth was more common in children whose level of control fluctuated. Thirty-four per cent of girls and 17 per cent of boys between 14 to 18 years of age showed accelerated weight gains and a drift toward obesity. Tendency for obesity was more common in subjects in the fair and poor levels of control. Emphasis was placed on the importance of prompt and complete management of childhood diabetes to prevent developmental retardation.

Bergqvist (1954) studied longitudinal growth in height of 56 Swedish children with diabetes over a period of 3.6 to 7.3 years. The 1942 Swedish growth standards of Broman, Dahlberg and Lichenstein were used for comparison. Subjects were allowed unrestricted food with the exception of concentrated carbohydrates, and all were treated with insulin. Most patients frequently exhibited in excess of four percent glycosuria, and thus potentially lost substantial amounts of energy via the urine. Twenty subjects 10 males and 10 females, whose ages at onset of diabetes ranged from five to 10 years, were significantly below the growth standard. Mean deviation from their normal growth line ranged from -3.7 centimeters for females to -4.9 centimeters for males. Females showed a tendency toward obesity once height retardation began. Height retardation was most pronounced in males. It was hypothesized that defective gonadal function might be responsible for this difference between the sexes; that androgens and estrogens each have different effects on skeletal growth. Familial tendencies toward shortness alone were not held accountable for the growth retardation of diabetic children. Poor diabetes control, undernutrition, pituitary hypofunction and excess of adrenocorticotropic hormone were all felt to be possible factors in the etiology of growth disturbances in diabetes.

Sterky (1967) noted that juvenile diabetics of at least 15 years duration were shorter than controls. This was most evident in males. Height at onset for males was increased over the norms, but became significantly less than controls after treatment. Skinfold measurements over three sites indicated increased body fat in females and reduced muscle mass in males. It was not stated which skinfold measurements were taken. The presence of growth disturbances was also suggested when parent-child correlations for adult height were found to be less for diabetics than for non-diabetics.

Evans and Lister (1970) studied height, weight and subscapular skinfold thickness in a group of 104 juvenile-onset diabetics. Most of the children fell between the 10th and 90th percentiles for these measurements. However, more females fell above the 50th percentile for weight than below, and a greater number of boys fell below the

50th percentile for height than above it. A small degree of height retardation was noted in boys and girls with duration of diabetes greater than six years. Subscapalar skinfold measurements were increased for both males and females. The Tanner and Whitehouse standards for height, weight and subcutaneous fat (1962) for British children were used for comparison.

A population of 94 juvenile diabetics was studied by Birkbeck (1972) in which height, weight, height velocity and skeletal maturity information was described and compared to a control population. All subjects were followed longitudinally over one to five years. The height and weight standards used were the third, 50th and 97th percentiles reported by Tanner et al. (1966). Diet was felt to provide "adequate" protein and calories, although no standards for nutritional adequacy were mentioned. Suboptimal growth was not noted to occur in this study group, and subjects who were shorter than controls were shown to have familial tendencies for short stature. Some subjects showed considerable variation in their actual centile position from year to year, but the researcher was not able to correlate these changes with fluctuations in metabolic control. Skeletal maturity was not different from that of the control population. There was no relationship between age at onset of diabetes and shorter stature, and the author concluded that unless therapy is inappropriate, diabetes mellitus is not associated with growth problems.

In a study based on 116 children with IDDM Jivani and Rayner (1973) assessed growth velocity. Degree of diabetes control was determined on the basis of urine testing, clinic records of glycosuria, ketosis, blood sugar levels and incidence of hypoglycemia. Diet for this sample supplied 40 percent of total calories as carbohydrate (proportions of protein and fat were not mentioned), and insulin was used once daily in all but a non-specified number of adolescents, who received two injections daily. Height at onset was not significantly different from the 50th percentile of the 1966 standards of Tanner, Whitehouse and Takaishi. Pubertal growth spurt in females was generally reduced or delayed, with no effect from level of control of diabetes. Males' growth spurt was also reduced and delayed, but an effect of level of control emerged at pubertal onset. Poorly controlled diabetics had a near-normal pubertal growth spurt, while the well controlled subjects had a lower and later growth spurt than the whole group. Males and females were significantly heavier than the norms one year after diabetes onset, but females became heavier still three or more years after onset. Males in good control exhibited the same pattern, but males in poor control did not continue to get heavier after the first year after onset. It was concluded that growth was not affected by control but growth retardation was associated with onset of the disease prior to the time of puberty.

Van Dyke et al. (1973) reported similar data from a study of 105 children with diabetes. Level of control was judged considering number of hospitalizations and urine glucose and ketone content. Seventy-four percent of males and 82 percent of females grew at or exceeded normal rates of growth, according to the 1962 Faulkner standards for white North American children. No correlation existed between level of diabetes control and growth rates.

The classic twin studies by Tattersall and Pike (1973) also presented evidence that early onset of diabetes, especially if prior to puberty, resulted in retarded growth and development, in spite of what was believed to be adequate treatment. Thirty-five pairs of identical twins were studied, one or both of whom had diabetes. Diabetics diagnosed prior to onset of puberty were on the average 2.25 inches shorter than their unaffected twins. Adult height was found to be lower in the diabetics than in their twins. When diabetes appeared after puberty in one or both twins, no significant difference was found in height. Inadequate diet was felt not to be the probable cause of the height retardation. It was stated that growth retardation occurred in all diabetic children, even when level of metabolic control was felt to be adequate. The researchers expressed, however, that criteria used to assess control were inadequate and that control in IDDM was almost always poor.

Jackson et al. (1978) studied 252 children with IDDM in terms of individual growth charts, control ratings and socioeconomic status over a time period which ranged from three to 17 years. Height and weight measurements were made at each clinic visit, which usually occurred at three to four month intervals. Iowa growth charts were used as standards until NCHS data became available. A general rating of diabetes control was made based on information regarding insulin requirements per unit body weight, frequency and degree of glycosuria and glycosylated hemoglobin. No differences in growth patterns were noted between children in "good," "good to fair" and "fair" control. Growth patterns were very similar to the Iowa norms except that girls and boys were heavier at eight and 11 years of age, respectively. When NCHS growth charts were used, the excessive weights were no longer evident, indicating a trend toward overweight among the American population. The authors stated that only children with lower degrees of metabolic control exhibit growth disturbances, and that such subjects' growth accelerates with attainment of higher levels of metabolic control. Socioeconomic status was shown to be a strong determinate of levels of control reached. As commonly found by other researchers, obesity became a problem with diabetic females after the pubescent growth spurt was complte. It was proposed that since diabetic children are closely supervised with regard to sound nutritional practices, the quality of their nutritional intake was "superior to that of the healthy children from whom the growth norms were derived" (Jackson et al., 1978, page 100).

Schvaneveldt (1980) studied 202 children and adolescents with IDDM between the ages of eight to 15 years. It was found that 14 to 15 year old males and 14 year old females were significantly shorter than the 1976 National Center for Health Statistics (NCHS) population data. Females fell into an equal distribution above and below the 50th percentile for height, while the majority of males were less than 50th percentile for height for age. Eight-year old males were heavier, and 12, 14 and 15 year old males were significantly lighter than the NCHS control group. Twelve year old females were also lighter. A general trend toward decreasing height and weight percentiles with increasing age was apparent for both males and females. Glycosylated hemoglobin levels and height percentiles were unrelated. Tendency for height retardation increased with duration of disease, as well as diagnosis at or before eight years of age.

Edelsten et al. (1981) studied 77 children with IDDM and confirmed previous reports of increased height at onset of diabetes, particularly in males less than 10 years of age. Normal stature was observed at onset in girls, but they went on to exhibit significant growth retardation after treatment. While boys showed short stature after treatment to a lesser degree than girls, their rate of growth slowed markedly after onset. Since they were generally tall for their age at onset, decreased growth rates would have less effect on their final stature than in girls. Both boys and girls were found to have advanced skeletal maturity at onset of their diabetes, as Evans and Lister (1970) had previously described.

Mella (1981) published results from a study of 100 insulin-dependent children. Control was classified as poor or satisfactory, based on the degree of glycosuria and incidence of ketoacidosis after diagnosis of diabetes. After puberty, marked growth delays were observed in males in poor metabolic control. Females in poor control showed sub-optimal growth in height but not weight. Children with satisfactory levels of control grew at normal rates. A positive correlation was found between short stature and duration of disease.

Rudolf et al. (1982) measured growth velocity in nine diabetic patients whose ages ranged from 10 to 20 years, before and after six months of intensive treatment with either an insulin pump or multiple insulin injections. Despite elevated $HgbA_1$ levels (mean 12.4 ± 3.0 percent), growth velocity during conventional therapy was described to be within the normal range for all but one subject. Normal range, according to tabular data, was above the fifth percentile for age and sex as dictated by values from the National Center for Health Statistics growth curves (1977). It was interesting to note that only two of the nine subjects were at or above the 50th percentile for height for age, and that no subjects exceeded the 75th percentile. The authors reported that growth velocity increased sharply during the intensive insulin treatment over what was considered to be normal initially. It was concluded that "metabolic changes accompanying intensive insulin treatment may enhance growth in diabetic children, even in those with apparently normal growth velocity during conventional therapy (page 338)." In editorial correspondence to the Journal of Pediatrics, Rothstein (1983) criticized Rudolf et al., stating that there was insufficient information regarding pubertal staging and growth velocity data to have made this conclusion.

Metabolic Control

"One of the most difficult aspects of treating a diabetic patient is evaluating how effective the treatment regimen has been in keeping blood glucose levels at near-normal" (Gabbay and Whitehouse, 1981, page 1). Until recently no method existed for measuring chronic blood glucose control. Urine testing remains a widely used method for evaluation of diabetes control but only reflects blood glucose levels near the time of determination. In addition, patients' records of at-home urine testing may appear impressive, but accuracy and reliability are often questionable. Occasional measurements of 24-hour urinary glucose output cannot be regarded as an index of day-to-day diabetes control, either (Mann and Johnston, 1982). Spontaneous blood glucose determinations also do not reflect chronic glycemic status, and are affected by emotions, current illness and interruption of daily routine. Glycosylated hemoglobin levels, unlike spontaneous blood or urine glucose values, are a relatively objective measure of longer-term control, and are independent of time of day, insulin administration, meal times, illness, and current blood glucose levels.

Glycosylation of hemoglobin is a slow, nonenzymatic process which occurs during the life of the red blood cell. The process is irreversible, and the degree to which glycosylation occurs is indicative of the concentration of glucose the hemoglobin has been exposed to. The time period reflected by glycosylated protein depends on the turnover rate of a particular protein. The life of the red blood cell is known to be 120 days (Gabbay and Whitehouse, 1981) and glycosylated hemoglobin levels reflect blood glucose levels for the preceeding two to three months (Williams and Savage, 1979; Mann and Johnston, 1982; Nathan, 1983).

In the non-diabetic individual, less than 10 percent of hemoglobin A is glycosylated. There are three glycosylated hemoglobins: HbA_{1a}, HbA_{1b} and HbA_{1c}. Of these HbA_{1c} comprises the greatest fraction and appears to correspond most to the degree of hyperglycemia (Williams and Savage, 1979). Non-diabetic individuals have values that fall between five to ten percent, while diabetics can range from eight to 23 percent. Values higher than 11.5 percent warrant investigation regarding appropriateness of the current dietary, insulin and exercise regimen and/or compliance with treatment (Nathan, 1983).

Williams and Savage (1979) reported a mean HbA_{1c} value of 16.2 percent in children whose height velocity was less than the 10th centile compared to 12.4 percent in children whose height velocity was greater than the 10th centile. Mann and Johnston (1982) found that HbA_1 values from patients with diabetes of more than five years duration were higher than those of patients having the disease for less than five years.

Goldstein et al. (1982) reported an increase in HbA_{1c} values as endogenous insulin supply decreased. The mean HbA_{1c} level was significantly lower in males than in females (8.93 ± 0.15 percent vs. 9.91 ± 0.24 percent; $p<0.001$) and values greater than 12 percent were found in 13 percent of females studied, but in only 3 percent of males. No difference in mean HbA_{1c} values between sexes was noted when disease duration was less than two years. Daneman et al. (1981) indicated a tendency for HbA_{1c} to increase with age more than with duration, particularly with adolescent females. This was attributed to hormonal changes occurring with pubertal development. The phenomenon was noted to cease after 16 years of age, possibly due to the stabilization of sex hormone levels at this time. Mann and Johnston (1982) also discovered a sex difference in HbA_{1c} values, where females' mean was 13.6 ± 1.9 percent vs. males at 12.8 ± 2.3 percent, when subjects were greater than 12 years of age. The sex difference has been attributed to emotional problems, deterioration of control around the time of menstration and problems with over-insulinization. During the past 10 years laboratory techniques for determination of HbA_{1c} have become more refined. A method of microcolumn chromatography is most commonly employed.

It is imperative to effectively eliminate the labile aldimine fraction from the final test solution. This fraction results from an intermediate step in glycosylation and is of substantial quantity if serum glucose levels are high. If not eliminated, a false high HbA_{1c} value will result. Proper incubation techniques must be utilized to ensure complete elimination of the aldimine component.

The test is also highly temperature-sensitive, and minute changes in environmental temperature can alter results. Most of the more recently developed or modified assay techniques involve some type of correction factor for changes in temperature (Gabbay and Whitehouse, 1981).

False high or low values might also result from various physiologic conditions of the patient. If certain anemias exist, values may be distorted due to the presence of abnormal hemoglobins. Such anemias are thalassemia and sickle cell anemia (Nathan, 1983). Infants up to one year of age may have inaccurate values due to the presence of fetal hemoglobin. Uremia, acidosis and the presence of certain common drugs (such as aspirin and penicillin) in the system can result in altered values (Gabbay and Whitehouse, 1981).

Dietary Intake of Individual with Diabetes

Prior to the discovery of insulin in 1922, diets used in the treatment of diabetes often led to severe malnutrition. Caloric restriction was characteristic of most regimens, although components of diets varied greatly. Rancid fats and meats comprised one regimen commonly used in the late 1700's and on into the early 1800's, based on the belief that removal of carbohydrate from the diet would prevent its appearance in the urine. Later in the 19th century virtues of diets containing substantial amounts of sugar candy, oatmeal and potatoes were proclaimed for the purpose of replacing carbohydrate lost in the urine. This later belief began the trend toward the use of higher carbohydrate diets for therapy in diabetes (Wood and Bierman, 1972).

Since the initiation of insulin therapy, diabetic diets have become more like those of the non-diabetic population. Controversy exists still over the appropriateness of unmeasured diets for use in juvenile diabetes. The "free" or "unmeasured" diets described in the literature generally involve the avoidance of concentrated sweets, regular timing of meals and consistency of amounts of food consumed each day. An exception to this was the so-called "free" diet described by Jacobi (1954) where the subjects had received no dietary counseling and followed no guidelines or restrictions. The use of unmeasured dietary patterns has been reported to result in levels of metabolic control similar to those of groups following measured diets (Guest, 1947; Jacobi, 1954; Forsyth and Payne, 1956; Sterky, 1967 and

Knowles et al., 1965), which involve careful weighing and measuring of foods.

Jacobi (1954) studied dietary intake patterns of 120 juvenile diabetics between 10 and 17 years of age, both while at home and at summer camps. Calorie levels recommended by the Food and Nutrition Board of the National Research Council (FNB NRC) were used as standards. Thirty-seven of the subjects followed no dietary restrictions and had had no dietary instruction. Those individuals were classified to be on "free" or "unrestricted" diets. Of the subjects not on the free diet, one-fifth of males and one-third of females followed prescribed patterns. Three percent of females and no males consumed less than their prescribed calorie level. Fifty-two percent of males and 29 percent of females took in 1.5 times the prescribed calories or more. Of the subjects on free or uncontrolled diets, 47 percent of males and 60 percent of females consumed appropriate calorie levels. Fifty-three percent of males and 40 percent of females consumed 1.5 times or more calories than considered to be appropriate. Subjects of both sexes who consumed over 3000 calories while at home tended to be overweight. Some diet prescriptions were found to be inadequate, thus accounting for some of the intakes above prescribed levels. Insulin dosages were generally lower at camp than at home. This was attributed to increased activity, in addition to a lower amount of carbohydrate in the camp diet. Subjects were described as consuming carbohydrate in excess at home in the form of extra bread, fruit and milk in addition to ice cream, cakes, cookies and candies, especially in the 14 to 17 year age range. Many, it was felt, did not have adequate dietary instruction and had little knowledge of the relative nutrient content of foods.

Wilkins et al. (1955) presented intake of calories and seven nutrients of 71 juvenile diabetics ages one to 18 years, who were described as having "maintained a high degree of control of their disease throughout childhood" (page 24). Methods used to evaluate diabetes control were not stated. Each family had undergone extensive education pertaining to fundamentals of good nutrition. The 1953 RDA was used for comparison. Caloric intakes tended to be lower than recommended values, but the diets provided protein, calcium, vitamin A and riboflavin in excess of the standards. Iron, thiamin and ascorbic acid were received in appropriate amounts. Exercise and its effect on calorie needs was discussed, and each family was instructed on how to adjust intake with varying activity levels. The need for individualization of diet plans was emphasized, particularly in terms of growth, activity levels, maturation and insulin type and dosage. It was felt that diets designed for use with IDDM should be flexible, but that no child, diabetic or not, should eat without supervision and direction, as habits are carried into adult life.

Knowles et al. (1965) observed 108 juvenile diabetics for a period of 10 years. Since compliance with measured diets appeared to be poor, and even resulted in behavior problems and hostility, an unmeasured diet plan was initiated. Carbohydrate, protein and fat were to be ingested in "proportions of the average American diet." Subjects were instructed to consume approximately the same amounts of food at the same times each day, and large quantities of food, especially carbohydrates, were to be avoided. Food did not need to be carefully measured. Protamine zinc and regular insulins were used prior to the availability of intermediate-acting types. One injection was given daily unless infection or other types of stress occurred. In the event that hyperglycemia was indicated by symptoms familiar to the subjects such as "sudden mouth dryness," more than one injection daily was also given. Dietary histories were conducted during the last three years of observations. The subjects were asked to describe "the average intake at each meal. This was then checked with relatives." Estimates of total calories, amounts of carbohydrate, protein and fat were made using the 1956 edition of Bowes, Church and Church. Total calories per pound were found to be appropriate as compared to current literature recommendations for diabetes, but below the 1958 RDA. Males tended to consume more fat and females more carbohydrate. Males 14 to 19 years of age consumed a mean of 41 percent of calories as carbohydrate, 17 percent as protein, and 42 percent as fat. Females 15 to 19 years of age had mean intakes of 43 percent, 19 percent and 38 percent of total calories as carbohydrate, protein and fat, respectively. These proportions were almost identical to the values recommended by Caso (1950). Fats were mainly of animal origin. At this point in time, no recommendations regarding polyunsaturates were made.

Recommendations for Diet in IDDM

Diet, both before and after the discovery of insulin, has been considered the cornerstone of diabetes therapy (Nuttall, 1983).

"Diabetic diets" are prescribed for both Type I and Type II diabetes, although actual dietary guidelines given to patients vary greatly. The following is a discussion of current issues in this area, and of recommendations for diet in diabetes by the nutrition and medical communities.

Exchange Systems

To plan a diet for an individual with diabetes, a basic meal plan must be developed. If the diabetic is to adhere to this plan, yet still be permitted to choose the foods he or she wants, a substitution system is necessary. For this purpose, variations of an exchange system were designed. Currently the most widely used system of this type is the Exchange Group System developed by the American Diabetes Association (1976). Six exchange lists are included (Table 1) which contain foods that, with the exception of concentrated sugars, can be incorporated into this system (Skyler, 1983). The "Food and You" system (Prater et al., 1982) is a variation of the exchange approach to meal planning designed especially for use with the young diabetic. It combines the concept of sound nutrition practices with an exchange-type grouping of food "choices" called the "Diabetic-Four-Plus-One-Food-Groups." These include Milk, Vegetable and Fruit, Bread and Cereal and Meat, Egg and Cheese and the "Plus One" Fat choice group. Information is provided for use of combination foods such as casseroles and stews, and foods that are substantial sources of vitamins A and C, dietary fiber and cholesterol are designated as such.

Table 1. Calorie, carbohydrate, protein and fat content of one exchange from each exchange group.

	Calories	Carbohydrate(g)	Protein(g)	Fat(g)
1. Milk (skim)	80	12	8	trace
2. Vegetable	25	5	2	0
3. Fruit	40	10	0	0
4. Bread	70	15	2	0
5. Meat (lean)	55	0	7	3
6. Fat	45	0	0	5

Source: Skyler, J. 1983. Dietary Planning in IDDM. Pediatric Annals 12(9):652.

Recently studies have demonstrated that, contrary to concepts on which the exchange systems are based, foods of similar macronutrient composition have substantially different effects on post-prandial blood glucose response (Jenkins, 1982). The significance of these studies, however, has not yet been determined for the IDDM population. Although broad generalizations regarding the glycemic index have been made (Crapo, 1983) no recommendations based on this data are available and the traditional exchange-type systems based on similarity of macronutrient content of foods continue to be used (Skyler, 1983).

Macronutrient Content of the Diet

The macronutrient content of the diet is still subject for debate. Scientific data currently available do not support any one combination of nutrients for optimal glycemic control. Restricted carbohydrate diets were popular in past years, but a trend toward liberalization of carbohydrate has begun. Enhanced ability to regulate glucose clearance in non-diabetic and well-insulinized diabetic subjects has been found with higher carbohydrate diets (Brunzell et al., 1971). Negative effects of liberalized carbohydrate consumption have not been demonstrated in well-controlled diabetic individuals (Skyler, 1983). In addition, there is concern that fat consumption may be related to the incidence of cardiovascular disease. Since the incidence of cardiovascular disease is known to be higher in individuals with diabetes (Burgess, 1982), a reduction in fat intake for diabetic persons is indicated. In order to maintain isocaloric diets, intake of protein and/or carbohydrate would need to be increased. Since, unless carefully chosen, protein foods tend to provide substantial amounts of fat and cholesterol, increasing carbohydrate calories would make the most sense (Crapo, 1983). The American Diabetes Association (1979) has recommended that 50 to 60 percent of total calories be provided as carbohydrate, but that glucose and glucose-containing disaccharides be restricted. High-quality proteins should account for 12 to 20 percent of the energy intake and fats the remainder. Saturated fats should contribute no more than 10 percent of total calories, polyunsaturates 10 percent and monounsaturates the remainder (American Diabetes Association, 1979). Skyler (1983) has suggested that cholesterol intake by individuals with diabetes not exceed 400 milligrams per day. Although the American Diabetes Association continues to stand by these recommendations, underlying data supporting them is in need of further study (Nuttall, 1983). Current research in the area of diet composition for diabetes therapy continues to provide more defined information on which to base further recommendations.

Fiber

Fiber content of the diet has attracted much attention from the diabetes community. American (1979), Canadian (1981), and British (1981) Diabetes Associations have recommended increased fiber intakes for the purpose of reducing postprandial glycemic response. Fibers with higher viscosity (i.e., guar and pectins) have been shown to be most effective in reducing insulin and glycemic response in individuals with NIDDM, and glycemic response in IDDM patients (Jenkins et al., 1976; Jenkins et al., 1977). Non-viscous fibers such as wheat bran have also been used with some success in reducing glycemic response after meals (Miranda and Horwitz, 1978). No purified fiber preparations are currently available that are palatable, and without undesirable side effects (Crapo, 1983; Nuttall, 1983). High-fiber diets using natural foods have also been reported to improve diabetes control (Simpson et al., 1981). The results have been attributed to slowed gastric emptying and reduced rate of absorption from the small intestine. Malabsorption has not been indicated (Jenkins, 1982). These studies provide evidence that gastrointestinal events influence glycemic and endocrine response.

The Glycemic Index

Jenkins (1982) has described a concept called "lente," or sustained-release, carbohydrate. Foods with similar carbohydrate content have been shown to elicit substantially different glycemic responses, as compared to that resulting from an equivalent load of glucose (Table 2). This information has been compiled into a glycemic index, where

$$\text{glycemic response} = \frac{\text{area under 2-h blood glucose response curve for food} \times 100}{\text{area under 2-h blood glucose response curve for equivalent amount of glucose.}}$$

Comparisons of up to 60 foods and sugars tested in non-diabetic volunteers demonstrated 2-hour blood glucose response areas which ranged from 98 percent to 15 percent of their glucose equivalence (Jenkins et al., 1981). These differences have been partly attributed to fiber content and naturally-occurring enzyme inhibitors. Digestibility of foods has also been indicated, which might be

Table 2. Glycemic index: the area under the blood glucose response curve for each food expressed as a percentage of the area after taking the same amount of carbohydrate as glucose.*

100%	80-90%	70-79%	60-69%	50-59%	40-49%
glucose	cornflakes	bread (wholemeal)	bread (white)	buckwheat	spaghetti (wholemeal)
	carrots#	millet	rice (brown)	spahgetti (white)	porridge oats
	parsnips#	rice (white)	muesli	sweetcorn	potato (sweet)
	potatoes (instant mashed)	weetabix	shredded wheat	all-bran	beans (canned navy)
	maltose	broad beans (fresh)#	"ryvita"	digestive biscuits	peas (dried)
	honey	potato (new)	water biscuits	oatmeal biscuits	oranges
		swede#	beetroot#	"rich tea" biscuits	orange juice
			bananas	peas (frozen)	
			raisins	yam	
			Mars bars	sucrose	
				potato chips	

Table 2. (continued)

30-39%	20-29%	10-19%
butter beans	kidney beans	soya beans
haricot beans	lentils	soya beans (canned)
blackeye peas	fructose	peanuts
chick peas		
apples (golden delicious)		
ice cream		
milk (skim)		
milk (whole)		
yogurt		
tomato soup		

*Data from normal individuals (after Jenkins et al., Am. J. Clin. Nutr. 1981).

#25 g carbohydrate portions tested.

influenced by the presence of lectins, tannins, phytates, sugars, fats, proteins, starches, and/or any interaction between these, and other, substances (Jenkins, 1982). The mechanism of altered digestibility is, at this time, poorly understood. Since the exchange system for diabetes diet planning (American Diabetes Association, 1976) is based upon carbohydrate content of foods, and not physiologic glycemic response to those foods, many professionals have begun to question the appropriateness of the system, although it remains the most common system used to teach diabetic individuals (Skyler, 1983). In order to develop a more sound scientific basis for the exchange system, further research to evaluate the glycemic index of foods and meals must be done (Skyler, 1983; Nuttall, 1983).

Sweeteners Used in the Diabetic Diet

It has been recommended that glucose and glucose-containing disaccharides such as sucrose and lactose be restricted in the diabetic diet (American Diabetes Association, 1979). Although the exclusion of refined sugars from diabetic diets has been questioned due to lack of scientific evidence (Nuttall and Gannon, 1981; Nuttall, 1983), it continues to be practiced.

> "Satisfying the human craving for sweetness is considered by some authorities an important aspect of the process of acquiring good patient compliance with the diabetic diet prescription" (Talbot and Fisher, 1978, page 231).

Nutritive, non-sucrose sweeteners are those that provide calories, and include fructose, sorbitol, xylitol and aspartame. Saccharin is classified as nonnutritive (Crapo, 1983). These substances have been used as alternatives to sucrose in diets for diabetes.

Crystalline fructose has become widely available for clinical and commercial use. It was reported by Crapo et al. (1980) and Bohannon et al. (1980) that crystalline fructose had a substantially smaller glycemic response than glucose, sucrose and some complex carbohydrates in well-controlled diabetic subjects and non-diabetic subjects but may result in worsened glycemic control in poorly controlled diabetes. Short-term studies have indicated no reason to avoid intakes of less than 75 grams per day, but long-term studies on the effects of oral fructose intake in diabetes have not been reported (Crapo, 1983). Questions have been raised regarding the effects of fructose ingestion on lipid metabolism (Sestoft, 1979; Wood and Bax, 1982; Hallfrisch et al., 1983).

The polyalcohols sorbitol and xylitol have also been utilized as part of diabetic dietary regimens, especially in Western European countries (Talbot and Fisher, 1978). Their use has been reported to result in less postprandial hyperglycemia than regular dietary sugars because of slower absorption (Talbot and Fisher, 1978). Doses of greater than 30-50 grams per day have caused osmotic diarrhea (Wood and Bax, 1982). Chronic feeding of xylitol to laboratory animals has been associated with tumor induction and use of this substance is in need of further investigation (Federation of American Societies for Experimental Biology, 1978).

Aspartame was recently approved for use by the Food and Drug Administration (FDA) in 1981 (Crapo, 1983). It is the dipeptide of the methyl ester of L-phenylalanine and L-aspartic acid, and is approximately 160-220 times sweeter than sucrose. Because of this sweetness intensity only small amounts of aspartame are used, and substantial decreases in caloric content of foods can result (G.D. Searle and Co., 1982). Its use in cooking is limited as prolonged heat results in breakdown of the molecule and thus, loss of sweetness (Crapo, 1983). Aspartame has not been shown to influence diabetes control in individuals with NIDDM and IDDM (Stern et al., 1976), but studies in this area are limited (Horwitz and Bauer-Nehrling, 1983). Numerous questions have been raised since FDA approval about the safety of aspartame for use by the general public. Aspartame's manufacturers have claimed that metabolism of the dipeptide is similar to metabolism of the same amino acids occurring naturally in foods. Gellis (1984, pages 19-20) has reported information from an unpublished letter to the editor of the British Medical Journal from Timothy J. Maher, Ph.D., stating

> "All naturally-occurring foods which contain phenylalanine (i.e., as protein) also contain even larger quantities of other large, neutral amino acids that compete with phenylalanine for uptake into the brain. Hence, adding protein to a meal tends to decrease brain phenylalanine levels. In contrast, aspartame supplies the bloodstream with phenylalanine, but not with other large, neutral amino acids; hence its consumption increases brain phenylalanine (an effect which, in rats, is doubled if the animals concurrently consume carbohydrate, since insulin depresses plasma levels of competing large, neutral amino acids)."

Gellis (1983) had also summarized a study by Wurtman (1983) in which doubled brain tissue levels of phenylalanine were demonstrated in rats fed aspartame. The effect was again doubled by simultaneous ingestion of carbohydrate. Brain tissue levels of serotonin, 5-hydroxyindolacetic acid, tyrosine and tryptophan were also altered. Gellis (1983, page 18) responded to the above review stating,

> "Until further data are available, it seems to me that we cannot disregard Wurtman's findings, and for the present advise parents against soft drinks which have been sweetened with aspartame."

Concerns have also been expressed over the question of whether or not aspartame use can lead to methanol toxicity. The Food and Drug Administration (1983) continues to assure the public that measurable blood levels of methanol are not detectable until single aspartame doses substantially exceed projected 99th percentile exposure levels (34 mg/kg). Although aspartame has undergone extensive pre-market testing, and numerous studies report no danger of potential toxicity of amounts likely to be ingested, many questions remain unanswered. Further studies regarding the safety of this sweetener are indicated.

Saccharin remains available for public use despite a proposed ban due to possible carcinogenicity (Horwitz and Bauer-Nehrling, 1983). It is 300 to 400 times sweeter than sucrose and provides no calories, but has a bitter aftertaste (Crapo, 1983). Though its use is controversial, the American Diabetes Association (1978) has expressed that Federal restrictions on saccharin's use appear to need further justification.

Dietary Adequacy of Youth in the U.S. Population

The Nationwide Food Consumption Survey, 1977-78, which was conducted by the United States Department of Agriculture (USDA) has provided information regarding dietary intake of 8661 American subjects aged four to 65+ years. Average intakes of energy and 14 nutrients were calculated based on 24-hour recalls. The information was compared to the 1980 Recommended Dietary Allowances (RDA), which were adapted for use with this survey (Table 3). Results showed that:

- Energy intakes for six to 18 year-olds averaged 12.7 percent below the median 1980 RDA for age and sex.
- For the six to 18 year age groups, energy supplied by carbohydrate, protein and fat averaged 46.1 percent, 15.7 percent and 39.0 percent of total calories, respectively. This varied somewhat with age and sex (Table 4.)
- Protein, riboflavin, niacin and ascorbic acid intakes for the six to 17 year sex-age groups met the RDA in full.
- Phosphorous, vitamin A, thiamin and vitamin B_{12} intakes for six to 14 year age groups met the RDA in full. Fifteen to eighteen year-old females consumed 90 percent or more of the RDA for these nutrients.
- Intakes of calcium, magnesium, vitamin B_6 and iron were below recommended standards, especially among nine to 18 year-old females (Table 5).

Since nutritive values for magnesium, vitamins B_6 and B_{12} are not as reliable as those for other nutrients, it was recommended that these values be interpreted with care (USDA, 1980).

Dietary intake data have also been reported as part of the Second National Health and Nutrition Examination Survey, 1976-80 (NHANES II) which was conducted for the purpose of assessing the American population's health and nutrition status. In addition to data aquired

Table 3. Recommended dietary allowances (1980): adapted for use with the USDA Nationwide Food Consumption Survey, 1977-78.

Sex and age (years)	Food energy	Pro-tein	Cal-cium	Iron	Magne-sium	Phos-phorus	Vita-min A value	Thia-min	Ribo-flavin	Niacin	Vita-min B_6	Vita-min B_{12}	Vita-min C
	Kcal	G	Mg	Mg	Mg	Mg	IU	Mg	Mg	Mg(NE[1])	Mg	Mcg	Mg
Males and Females:													
6-8	2,100	32	800	10	229	800	3,071	1.1	1.2	14	1.5	2.8	45
Males:													
9-11	2,513	38	950	13	288	950	4,063	1.3	1.5	17	1.7	3.0	47
12-14	2,713	46	1,200	18	356	1,200	5,000	1.4	1.6	18	1.8	3.0	51
15-18	2,800	56	1,200	18	400	1,200	5,000	1.4	1.7	18	2.0	3.0	60
Females:													
9-11	2,325	39	950	13	269	950	3,688	1.2	1.4	16	1.7	3.0	47
12-14	2,188	46	1,200	18	300	1,200	4,000	1.1	1.3	15	1.8	3.0	51
15-18	2,100	46	1,200	18	300	1,200	4,000	1.1	1.3	14	2.0	3.0	60

[1] 1 NE (niacin equivalent) is equal to 1 mg of preformed niacin or 60 mg of dietary tryptophan.

from physical examinations, medical histories, biochemical assessment and body measurements, dietary intake information for energy and 17 nutrients was presented. Information was gathered using 24-hour dietary recalls. Weekend food consumption was not included. The data base used to determine nutrient value of foods include revised Handbook No. 8, sections 1 through 6 and Handbook No. 456. If a commercial food item was reported 20 or more times, nutrient values, if available, were provided by the manufacturer.

Using raw data drawn from the NHANES II survey (Table 6) and the 1980 RDA which were adapted for use with the USDA NFCS 1977-78 (Table 3), one can derive the following:

- Energy intakes for 6-18 year-olds averaged 12 percent less than the median RDA for age and sex.
- Intakes of protein, riboflavin, niacin and vitamin C met or exceeded the RDA for 6-17 year-olds of both sexes. Thiamin intake did not drop below 90 percent of the standard. The RDA for phosphorous was met by all subjects except 12-17 year-old females, whose intakes ranged from 88-94 percent of the standard. Intakes of calcium and iron tended to fall below the recommended standards, especially for 12 to 18 year-old females (Table 7).
- Cholesterol intake of six to 17 year olds averaged 250.5 milligrams for females and 346.0 milligrams for males.
- Energy supplied by carbohydrate, protein and fat averaged 49.2 percent, 14.7 percent, and 36.7 percent, respectively (Table 8).

Table 4. Percentage* of individuals' intake in a day, spring 1977.

Sex	Age (years)	Protein (%)	Fat (%)	Carbohydrate (%)
Males and females	6-8	15.6	37.6	47.8
Males	9-11	15.8	38.8	46.1
	12-14	15.5	39.9	45.5
	15-18	16.0	40.6	44.0
Females	9-11	15.4	37.4	48.3
	12-14	15.5	39.3	46.0
	15-18	16.1	39.6	44.8

*Percentages may not add up to 100 because of rounding.

Source: USDA Nationwide Food Consumption Survey 1977-78 - 48 conterminous states, Spring 1977 (preliminary).

Table 5. Nutrient intakes below 1980 Recommended Dietary Allowaces - USDA Nationwide Food Consumption Survey data. Average intake as percentage of 1980 RDA.

Sex	Age Range	90-99% RDA	80-89% RDA	70-79% RDA	Below 70% RDA
Males and females	6-8 years	magnesium vitamin B_6			
Males	9-11 years	calcium vitamin B_6	magnesium		
	12-14 years	calcium vitamin B_6	iron magnesium		
	15-18 years	calcium, iron vitamin B_6		magnesium	
Females	9-11 years	iron	calcium magnesium vitamin B_6		
	12-14 years	phosphorus		calcium magnesium vitamin B_6	iron
	15-18 years	phosphorous		magnesium	vitamin B_6 iron calcium

Source: USDA Nationwide Food Consumption Survey, 48 states, Spring, 1977 (Preliminary Report No. 2).

Table 6. Mean nutrient intake values for sex and age, all incomes, for 6-17 year-old subjects.

Sex	Age (years)	Calories	*S.E.	Pro (g)	S.E.	Fat (g)	S.E.	CHO (g)	S.E.	Ca (mg)	S.E.	Phos (mg)	S.E.	Fe (mg)	S.E.	Vit A (IU)	S.E.	Thi (mg)	S.E.	Ribo (mg)	S.E.	Nia (mg)	S.E.	Vit C (mg)	S.E.	CHOL (mg)	S.E.
Males	6-8	1981	40	73	1.5	81	2.3	244	4.8	1074	29	1321	28	12.53	.25	4893	200	1.43	.03	2.24	.04	17.78	.33	105	7.5	301	14.5
	9-11	2183	39	81	1.7	86	2.1	276	5.1	1116	33	1428	31	14.44	.38	5735	263	1.63	.04	2.46	.06	20.66	.52	119	6.1	304	9.3
	12-14	2430	57	90	2.3	99	3.2	299	6.1	1176	53	1576	47	15.88	.39	5976	451	1.73	.04	2.60	.08	22.90	.61	123	7.5	360	14.5
	15-17	2817	60	111	2.8	116	3.0	330	7.4	1333	46	1840	46	17.45	.45	5988	647	1.87	.05	2.91	.09	26.69	.93	112	7.2	419	13.6
Females	6-8	1807	33	64	1.3	72	1.5	230	4.5	978	29	1180	27	10.85	.25	4593	154	1.23	.03	1.99	.05	14.99	.30	109	5.1	255	11.3
	9-11	1857	39	67	1.7	75	1.7	233	5.4	944	42	1203	36	11.45	.29	4704	329	1.29	.04	2.01	.07	16.43	.39	94	4.5	248	7.6
	12-14	1813	33	65	1.4	74	1.6	224	4.4	859	30	1130	29	10.77	.35	3977	202	1.16	.03	1.73	.05	15.26	.41	83	5.0	252	9.3
	15-17	1731	51	63	1.9	73	2.9	205	6.6	764	36	1061	35	9.86	.26	3636	180	1.08	.03	1.61	.06	14.67	.44	73	3.0	247	12.0

*Standard error of the mean

Source: Dietary Intake Source Data: United States, 1976-80
The Second National Health and Nutrition Examination Survey (NHANES II)

Table 7. Nutrient intakes below 1980 Recommended Dietary Allowances for 6-17 year-old subjects from NHANES II data.

Sex	Age Range (years)	90-99% RDA	80-89% RDA	70-79% RDA	Below 70% RDA
Males	6-8				
	9-11				
	12-14	calcium (98%)	iron (88%)		
	15-18	iron (96.9%)			
Females	6-8				
	9-11	calcium (99.4%)	iron (88%)		
	12-14	phosphorous (94.2%) vitamin A (99%)		calcium (71.6%)	iron (59.8%)
	15-18	vitamin A (90.9%) thiamin (98.2%)	phosphorous (88.4%)		calcium (63.7%) iron (54.8%)

Sources: 1) Dietary Intake Source Data: United States, 1976-80. The Second National Health and Nutrition Examination Survey (NHANES II).
2) Adaptation of 1980 RDA for use with the USDA Nationwide Food Consumption Survey 1977-78.

Table 8. Percentage of 6-18 year-old individuals' calories supplied by each of the major nutrients: NHANES II.

Sex	Age (years)	Protein (%)	Fat (%)	Carbohydrate (%)
Males	6-8	14.7	37.0	49.3
	9-11	14.8	35.5	50.6
	12-14	14.8	36.7	49.2
	15-17	15.8	37.1	46.9
Females	6-8	14.2	35.9	50.9
	9-11	14.4	36.3	50.2
	12-14	14.3	36.7	49.4
	15-17	14.6	38.0	47.4

Derived from: The Second National Health and Nutrition Examination Survey (NHANES II); National Center for Health Statistics, Carroll, M.D., Abraham, S., and Dresser, C.M. Dietary intake source data: United States, 1976-80. Vital and Health Statistics Series 11 (231). DHHS Publication No. (PHS) 83-1681. Public Health Service. Washington, U.S. Government Printing Office, March, 1983.

Description and Validity of Dietary Survey Methods

Dietary studies are employed to determine sources and amounts of nutrients consumed by individuals or by groups of individuals. While these study methods cannot be interpreted as absolute representations of dietary intake they are used widely "to obtain presumptive evidence of dietary inadequacies or excesses in individuals, specific population groups, institutions or other community agencies" (Christakis, 1974, page 11).

Methods used to collect dietary data include the recall, which involves remembering food consumption patterns, and the food record, where the subject or researcher records all that is eaten as foods are consumed throughout the day. Food frequency lists are used to record how often various foods are consumed in a given time period, but amounts of food are not recorded and no quantitative assessment of nutrients can be calculated (Beal, 1980).

The 24-hour recall, which requires the client to recall all that was consumed for the 24 hours prior to the interview, has been described as "the least meaningful and least productive of dietary survey methods" (Beal, 1980, page 86). Carter et al. (1981) studied validity of the recall method using a population of 10 to 12 year-old children, and found it to be of little value as an indicator of actual intakes. Subjects often do not remember the details of food consumption and this method may result in overestimation of a population's risk for malnutrition (Beal, 1980). Since only one day is reflected, it may not be a reliable indicator of usual food practices. It has generally been used to obtain qualitative rather than quantitative information, since recall of precise amounts of food is often poor (Mason et al., 1982). The accuracy of this method, however, can be enhanced through the use of skilled interviewers, motivated subjects, and by randomly increasing the number of days on which recalls are taken. The use of food models, measuring utensils and commonly used tableware may enable the client to be more precise in remembering and describing amounts of foods. Due to ease, time, cost and personnel considerations this method continues to be widely used. It is considered by many researchers to be a highly satisfactory method of dietary data collection (Mason et al., 1982).

Food intake records involve recording food consumed throughout the course of a day. Amounts of food can be estimated, measured in common household measuring units or precisely weighed and measured. Validity of this method has been questioned as subjects may not remember or desire to record foods as they are eaten, and because individuals might change their eating behaviors simply because they are keeping records (Mason et al., 1982). Chalmers et al. (1952) discussed the issue of the number of days recalls are to be kept. Increasing precision was reported in association with increased number of days for groups of 10 to 25 subjects. Use of one-day records could be justified only for the purpose of characterizing a group by its mean intake of nutrients. A number of sources have supported the use of the three-day food intake record (Young and Trulson, 1960; Stuff et al., 1983), as it has been shown to approach or meet the validity of 7-day records.

The question also arises as to which days of the week to use. By eliminating the weekend, nearly 30 percent of the week's intake patterns are ignored. Weekend days' intakes have been shown to differ significantly from weekday patterns (Chalmers et al., 1952), and an inaccurate impression of average daily intake patterns might result if they were excluded.

Limitations of any dietary history method are described well by Christakis (1974), and include the following considerations:

- there are differences in nutritional requirements among individuals;
- the so-called "conditioning factors" such as concurrent disease and genetic or enzyme defects which may interfere with or modify an individual's injestion, absorption, storage, utilization, requirement, destruction or excretion of nutrients;
- the skill of the history-taker and the degree of cooperation and memory of the subject;
- inadequacy of short-term studies which may not reflect total nutrient intake over longer time periods;
- the state of analytical methodology of nutrients is constantly evolving, and current values may not be completely accurate.

Trulson and McCann (1959) discuss the importance of recognition of potential errors and limitations of the various methods of collecting dietary data. They conclude that "no one technique of evaluating food intake that is practical for field conditions gives a completely reliable pattern of the characteristic intake of the individual" (page 676). There are, however, considerations to be made in selecting one method over another, depending on the intent and objectives of each researcher (Beaton et al., 1983).

CHAPTER III

METHODOLOGY

Subjects

The study sample consisted of 22 subjects, 10 males and 12 females, with IDDM ranging in age from seven to 16 years. All but one subject regularly attended a diabetes clinic at Primary Children's Medical Center (PCMC) in Salt Lake City, Utah. The clinic provided multidisciplinary care for young people with diabetes, and patients had access to social workers, pharmacists, a diabetes teaching nurse and a dietitian, in addition to one of two pediatric endocrinologists. The subject who did not regularly attend the clinic had attended a winter diabetes camp sponsored by the Utah Affiliate of the American Diabetes Association. Criteria for selection of the subjects included: 1) that subjects were insulin-dependent diabetics who were in the seven to 16 year age range and 2) that they had no other known health problem, aside from their diabetes, that would affect growth and food intake.

Research Design

This study was designed for the purpose of describing this sample of diabetic youth in terms of duration of diabetes, glycemic control, dietary intake patterns and anthropometry. Data was observed in a cross-sectional manner. Statistical analysis involving linear regression and correlation were used to determine relationships between duration of diabetes and growth parameters, duration of diabetes and metabolic control, metabolic control and growth parameters, and day-to-day variability and HbA_{1c}. T-tests were used to determine significance between males' and females' mean glycosylated hemoglobin values, cholesterol intakes and P:S ratios.

Analysis of variance was used to examine day-to-day variability between intake of total energy, calories, protein, fat and carbohydrate.

Procedures and Materials

Consent

Subjects and/or parents were approached upon arrival at the PCMC diabetes clinic and after being given a brief description of the study and its purpose, were asked if they would participate. Subjects agreed to participate on a voluntary basis. Except for the skinfold measurements and dietary records/questionnaire, all procedures necessary for provision of information (blood sampling, height and weight measurements) for the study were done routinely at PCMC diabetes clinic. Therefore, all subjects and/or parents, with the exception of the one individual recruited from outside the clinic, consented verbally to requests for participation. In this particular case, a consent form (Appendix A) was signed by the subject and a parent, as blood needed to be drawn for the purpose of the study.

Dietary Information/Questionnaire

A handout package was given to subjects at the clinic, which included instructions and examples (Appendix B) to facilitate recording of accurate, complete dietary information. A subjective questionnaire (Appendix B) was also given and a self-addressed (to the researcher) stamped envelope was included. Components of the package were explained in detail to the subject and parent(s). Individuals were instructed to carefully record their food intake for three days, one of which was to be a weekend day, using common household measuring units portrayed on the example sheets (Appendix B). Emphasis was placed on the importance of honesty and accuracy when recording intakes.

Anthropometry

Height. Height was measured using a Continental platform scale with a movable measuring rod. The subjects were in stocking feet and instructed to stand as straight as possible, but not to stretch, as this may add up to one centimeter to the final height. Back and heels were against the upright bar of the height rod, the head in the Frankfort plane, looking straight ahead. The horizontal bar was brought down snugly to the subject's head, and the measurement taken to the nearest 0.5 centimeter.

Weight. Weight was also measured in stocking feet, in light clothing while the subject remained still. The Continental beam scale was used to determine weight to the nearest 0.1 kilogram. Due to timing of the clinic, it was not possible to obtain weights before the subjects consumed their morning meal. No correction was made for the weight of clothing.

Triceps skinfold (TSF). Measurements for TSF were taken using the bare right arm. The subject bent the arm across the stomach. The halfway point between the acromium process of the scapula and the tip of the olecranon process of the ulna was located using a flexible, non-stretch measuring tape, and marked with a pen at the back of the arm. Both arms were then allowed to hang in a relaxed manner down at the sides. The examiner grasped a layer of skin and subcutaneous tissue with the index finger and the thumb, making sure the tissue was pulled cleanly away from the underlying muscle. Lange skinfold calipers (manufactured by Cambridge Scientific Industries, Inc., Cambridge, Maryland 21613) were then placed over the skinfold at the marked midpoint at a depth about equal to the thickness of the fold. This brand of caliper was used for skinfold measurements reported in the surveys conducted by the National Center for Health Statistics, and compresses the fatfold with a constant pressure of 10 grams/millimeter (NCHS 1972; 1975). The caliper was then released and, after three seconds, the reading was taken (Grant, 1979). A total of three readings were taken, the calipers released between each. These were averaged and recorded to the nearest 0.5 millimeter.

<u>Midarm circumference and midarm muscle circumference (MAC and MAMC)</u>. MAC was determined using the same midpoint used for the triceps skinfold measurement. The arms hung down at the sides in a relaxed manner, and a flexible, non-stretch measuring tape was placed around the circumference of the arm at the midpoint. The tape was drawn firmly, but not tightly, around the arm. The value was recorded to the nearest 0.1 centimeter. As Grant (1979) describes, the MAMC was calculated:

$$MAMC_{(centimeters)} = MAC_{(centimeters)} - \left(\frac{TSF}{10}_{(millimeters)} \times pi \right)$$

WHERE: pi = 3.14

Subscapular skinfold (SSF). SSF was measured by marking a point one centimeter below the inferior angle of the right scapula. In a way similar to the grasping of skin for TSF, the skin and subcutaneous tissue were pulled away from the muscle tissue approximately one centimeter from the mark. Three readings were taken with Lange skinfold calipers and the average recorded to the nearest 0.5 millimeter (NCHS, 1972; 1975).

Weight:height ratio. Weight:height ratio was calculated by dividing each subject's weight percentile value by that subjects height percentile value (Beal, 1980).

Glycosylated Hemoglobin Determinations

Glycosylated hemoglobin values were obtained at the PCMC laboratory using the ISOLAB microcolumn chromatographic technique. The values were corrected for temperature fluctuations using a correction chart supplied by the ISOLAB company. An aldimine eliminator solution was also employed to eradicate the labile fraction which can distort the final HbA_{1c} values. Determination of HbA_{1c} requires 1.5 to three milliliters of blood. This procedure was performed as a routine part of each clinic visit by PCMC laboratory staff. The one subject who was recruited from outside the clinic had blood drawn for the purpose of the study. This determination was performed by the PCMC laboratory staff, as well, after a consent form was signed by the subject and a parent.

Duration of Diabetes

The duration that each subject had IDDM was determined by subtracting the date (year and month) the disease was diagnosed from the year and month the measurements were taken. Duration was recorded to the nearest 0.1 year. Information regarding duration of diabetes was obtained through personal interview during the clinic visit, from take-home questionnaires and from each subject's medical record.

Age at Onset

Age at onset of diabetes was calculated by subtracting birthdate from the year diabetes was diagnosed. This was recorded to the nearest 0.1 year.

Analysis

Anthropometry. All individual height and weight, SSF, TSF and MAMC measurements were mathematically converted to percentile values corresponding to growth and skinfold data reported by the NCHS (1972; 1975; 1977) and upper limb skinfold and muscle area norms (Frisancho, 1981), as proposed by Schvaneveldt (1980). The assumption was made that a linear distribution occurred between the given percentile values (5, 10, 25, 50, 75, 90, 95). These percentile values are located in Appendix C. It was determined which percentiles an individual measurement occurred between and the following formula was applied to obtain the precise percentile value of the observation:

$$\frac{e-c}{d-c} \times (b-a) + a = P$$

WHERE:

a = lower percentile (i.e. 10, 25)

b = upper percentile (i.e. 50, 75)

c = lower percentile value (in kilograms or centimeters)

d = higher percentile value (in kilograms or centimeters)

e = subject's height (centimeters), weight (kilograms), SSF (millimeters), TSF (millimeters) or MAMC (millimeters)

*a,b,c and d values from tables in Appendix C corresponding to the age and sex of the e value

<u>Description of anthropometry standards used</u>. The anthropometric standards used in this study include the smoothed height and weight percentile tables published by the NCHS in 1977, subscapular skinfold thickness percentiles also published by the NCHS for six to 11 year-olds and for 12-17 year-olds (1975), and norms for triceps skinfold thickness and MAMC published by Frisancho (1981). The NCHS published data for height, weight and subscapular skinfold which were derived from three separate surveys: 1) the Health and Examination Survey (HES), Cycle II, of children six to 11 years of age, which was conducted from 1963-1965; 2) HES Cycle III of youths 12 to 17 years of age, conducted from 1966 to 1970, and 3) the Health and Nutrition Examination Survey (HANES I) of children ages 1-17 years, conducted from 1971 to 1974. Due to similarity of sample designs, data from the three surveys were melded for consecutive age groupings and combined where certain age groups overlapped. The percentile values used for triceps skinfold and MAMC (Frisancho, 1981) were derived from data sets of HANES I collected during 1971 and 1974. At this point in

time, these percentile data are the most recent available and felt to be most representative of the U.S. population.

Dietary Data

The NUTREDFO nutrient analysis system was used to evaluate information from the three-day dietary intake records. The raw data were coded by the reseacher with numbers assigned for each food item. Household measures were converted from common household measuring units to grams, using unit conversion information for the same or similar food items listed in Agricultural Handbook No. 456 (1975) as examples. Means and standard deviations were calculated for each nutrient for males and females separately.

Description of data base. The Nutrition Education Information System (NUTREDFO) is a computerized data base which contains three data files and a nutrient analysis software program. It was developed jointly by Utah State University and the Nutrition Guidance and Education Research Division of the Human Nutrition Information Service, United States Department of Agriculture. NUTREDFO is unique in that there are no zero nutrient values in the data base. Imputations were done to estimate nutrient content of food items, and thus NUTREDFO provides more complete information than other data bases. In addition, NUTREDFO includes vitamin B_6 and zinc in its profile of nutrient information. These nutrients have seldom been included in other data bases.

The first file is a permanent nutrient file which houses data for approximately 460 frequently consumed, widely available foods in the most basic edible states. Food mixtures such as casseroles and stews were generally not included in this file due to potential differences between recipes. However, items which tend to have a standard accepted composition, such as ice cream or cakes, or that are commonly used in packaged forms, such as canned soup or baked beans, were included. Contents of the permanent file are grouped into 9 major food categories: Fruits; Vegetables; Breads, Grains and Cereal Products; Milk, Cheese and Yogurt Products; Meat, Poultry, Fish and Egg Items; Fats and Oils, Sugars and Sweets; Desserts; and Other.

The second NUTREDFO file is a temporary nutrient file designed to enable users to temporarily store nutrient values for food items that are not part of the permanent nutrient data base. This feature enhances the versatility of NUTREDFO as a research tool.

The third component of the NUTREDFO system is the reference or documentation file. This allows users to have access to the source of every nutrient value used. At the time of this study, this feature was undergoing revision and was not used.

The nutrient analysis software program was designed to perform storage, retrieval and computation functions for individual research purposes. Functions utilized for this study include:

- calculating nutrient values of menus for individual eating occasions, individual days or a group of days;
- calculating percent of standards for nutrient totals, percent kilocalories from total protein, fat, carbohydrate and ethanol; calculating values for each nutrient and food constituent per 1000 kilocalories for each eating occasion and per day;

- calculating the mean, standard deviation, and minimum/maximum range for each nutrient and food constituent in a multi-day grouping of menus.

The NUTREDFO data base contains nutrient value information from the most recent sources available. The primary source of nutrient and food composition values has been food composition data published by the USDA (United States Department of Agriculture, Human Nutrition Information Service, 1983). This information was also used for computing imputations when necessary. The major source of data for NUTREDFO was Agriculture Handbook No. 8, "Composition of Foods... Raw, Processed and Prepared". Handbook No. 8 is currently being revised and is being published in separate sections according to food groups. Since not all sections of Handbook No. 8 had been revised by the time the data for this study were run (June, 1983), the 1963 edition of Handbook No. 8 was the source of nutrient information for NUTREDFO's data base. At that time however, information for some nutrients was available and obtained from more recent publications, such as USDA provisional tables and research articles from the Journal of the American Dietetic Association. Occasionally the Nationwide Food Consumption Survey (1976-77) data tape was consulted when nutrient values for specific items were not available from other sources. These data were often imputations.

The NUTREDFO data base, as with any other, is subject to the accuracy of the current status of analytical methodology. Certain of the known nutrients have what is determined to be acceptable analytical methodology, while not enough is known about others to have

Table 9. Acceptability of nutrient analytical methodology.

Nutrients with acceptable analytical methodology[1]		
Sufficient	Substantial	Tentatively acceptable
*calcium	amino acids (most)	amino acids (some)
copper	*cholesterol	arsenic
*magnesium	*fat (total)	chlorine
nitrogen	*fatty acids	chromium
*phosphorus	individual sugars	trans-fatty acids
*potassium	*iron (total)	*vitamin B_6
*sodium	manganese	
*zinc	*niacin	
	*riboflavin	
	selenium	
	*thiamin	
	*ascorbic acid	

Nutrients having limited analytical methodology[1]		
Conflicting Information	Fragmentary Information	Little or no Development
*food energy	biotin	cobalt
dietary fiber	choline	silicon
fluorine	heme-iron	tin
*folacin	molybdenum	vanadium
iodine	nonheme-iron	
*pantothenic acid	vitamin K	
*protein (total)		
starch		
sterols		
*vitamin A		
*vitamin B_{12}		
vitamin D		
vitamin E		

*Included in the NUTREDFO nutrient analysis system.

[1]Adapted from a presentation by Dr. Kent K. Stewart, Seventh National Nutrient Data Bank Conference, Philadelphia, Pennsylvania, May 3-5, 1982.

developed adequate methods for determination (Table 9). Although iron is listed among those nutrients with acceptable analytical methodology, the most representative values (which were aquired using iron-specific methods as opposed to methods based on protein content) are still not consistantly used in the available food/nutrient composition literature. For NUTREDFO, newer iron values (Exler, 1983) were consistently used when corresponding revised Handbook No. 8 data were utilized (i.e., all iron values in revised sections were new values).

Saturated fatty acid data, which was used in this study for calculation of P:S ratio, were from either revised Handbook No. 8 or Journal of the American Dietetic Association research articles. Value changes as a result of cooking or processing were imputed.

Added sugar values represent grams of carbohydrate in a product found in excess of carbohydrates naturally occurring in the food. All values for "added sugar", with the exception of ready-to-eat (RTE) cereals, were imputed.

Subject-specific RDA values for energy and protein. RDA values for kilocalories and protein used in this study were expressed as kilocalories or grams of protein per kilogram body weight for each individual studied. These values were calculated by first dividing the median RDA value for a nutrient by the median weight in kilograms listed for that age group to get a "per kilogram RDA value". The age-specific "per kilogram RDA value" was then multiplied by the weight of each subject to obtain a more specific estimate of kilocalorie and protein needs for each subject.

Example:

The median RDA value for energy for a 12 year-old, 40 kilogram male is 2700 kcalories, and the median weight value given for the 11 to 14 year age subgroup is 45 kilograms. The subject-specific RDA value for energy would be

2700 kcalories ÷ 45 kg = 60 kcalories per kg body weight

This value is then multipled by the subject's weight (40 kg) to get an individualized RDA value for energy of approximately 2400 kcalories.

P:S ratio. P:S ratio was expressed by taking the ratio of grams of total polyunsaturated fat to total saturated fat.

Range of intake of energy, protein, fat and carbohydrate. Range of intakes of energy, protein, fat and carbohydrate (Appendix M) were calculated by subtracting the least amount of a nutrient consumed from the largest amount of that nutrient consumed over the three-day period. For example, if a subject consumed 2200 kilocalories on day one, 2550 kilocalories on day two and 2110 kilocalories on day three, the range of kilocalorie intake for that subject would be 2550-2110 - 440 kilocalories.

Statistics

Simple linear regression and correlation matrices were utilized to determine relationships between:

A. metabolic control and growth parameters;

B. duration of disease and growth parameters;

C. duration of disease and level of metabolic control;

D. age at onset and growth parameters;

E. age at onset and metabolic control.

Analysis of variance was used to examine day-to-day variability of intakes of total energy, carbohydrate, protein and fat. Range of the intakes of nutrients over the three-day time period was then computed, and linear regression and correlation were employed to determine the relationship between range of intake for each nutrient and HbA_{1c} levels.

T-tests were used to determine differences between means for the following:

A. males' and females' mean P:S ratios;

B. males' and females' mean cholesterol intakes;

C. old and new values for the iron content of foods; and

D. males and females mean HbA_{1c} values.

MREGP, and SPSSX, and RUMMAGE were the statistical analysis programs used.

Statistical methods were not attempted to determine the differences between means of nutrient intake of the IDDM study population and the two national surveys (NFCS 1977-78 and NHANES II 1976-80) due to the small size of the sample used for this study. Instead, comparison of mean intakes of nutrients of the IDDM study group with those of the national survey population was portrayed using bar graphs, which were produced using TELAGRAF, a computerized graphics program.

CHAPTER IV

RESULTS AND DISCUSSION

Restatement of the Problem

Although the diabetes community has made great progress in the past decade in the areas of medical and nutritional care of the insulin-dependent diabetic population, growth disturbances in diabetic youth continue to be reported. Little is known, as well, about the optimal dietary prescription for individuals with IDDM, and about what people with diabetes actually consume. The purpose of this study was to describe a sample of 22 youth with IDDM in terms of anthropometry as compared to a non-diabetic control population, metabolic control and dietary intake information based on three-day dietary intake records.

Anthropometry

Individual percentile values for height, weight, SSF, TSF, MAMC and weight:height percentile ratios are located in Tables 10 and 11. Table 12 depicts mean values by sex for age, age at onset and duration of diabetes, HbA_{1c}, and all studied anthropometric measurements (as percentile values). Weight and height percentiles for all subjects are plotted on growth charts in Figures 1 and 2.

Height. Mean height percentiles for male and female subjects were 54.1 and 53.1 respectively. Five males and five females had height percentile values below 50, although no males were below 25. Two females, ages 11 and 15 years, had heights below the 10th

Table 10. Age, duration of diabetes, hemoglobin A_{1c} and anthropometry of 7-15 year-old males with IDDM.

ID #	Age (years)	Duration of diabetes (years)	Age at onset (years)	HbA_{1c} (%)	Height percentile	Weight percentile	SSF percentile	TSF percentile	MAMC percentile	Weight:Height percentile ratio
01	8.0	1.3	6.7	10.0	33.6	30.8	58.3	62.5	17.4	0.92
07	8.5	1.5	7.0	8.0	39.7	73.2	95.0	80.0	65.7	1.84
02	10.6	2.5	8.1	12.8	24.6	44.6	60.0	95.0	15.8	1.81
06	11.5	1.0	10.5	10.3	48.0	22.4	94.2	46.3	37.4	0.47
05	11.6	9.0	2.6	11.0	37.8	65.1	84.9	5.0	37.6	1.72
04	13.6	2.5	11.1	14.3	64.0	77.4	87.0	92.7	25.0	1.20
03	13.7	3.2	10.5	13.0	73.6	57.3	84.7	47.9	52.6	0.78
08	14.1	0.2	13.9	11.0	58.8	57.7	95.0	65.0	55.5	0.98
10	14.3	1.1	13.2	13.0	65.6	95.0	61.9	95.0	58.7	1.45
20	15.7	7.5	8.2	14.0	94.8	91.6	95.0	95.0	83.9	0.97

Table 11. Age, duration of diabetes, hemoglobin A_{1c} and anthropometry of 7-16 year-old females with IDDM.

ID #	Age (years)	Duration of diabetes (years)	Age at onset (years)	HbA_{1c} (%)	Height percentile	Weight percentile	SSF percentile	TSF percentile	MAMC percentile	Weight:Height percentile ratio
10	7.0	1.0	6.0	10.3	77.8	53.9	73.8	95.0	7.2	0.69
03	7.6	4.0	3.6	12.0	59.4	66.5	78.8	95.0	10.3	1.12
02	9.3	7.5	1.8	12.0	95.0	95.0	95.0	25.0	90.7	1.00
07	9.5	1.0	8.5	13.0	27.2	36.8	19.0	87.4	9.6	1.35
04	9.6	0.5	9.1	13.0	95.0	78.3	63.1	58.3	41.9	0.82
08	10.4	0.3	10.1	9.0	50.0	31.2	33.3	7.5	89.7	0.62
01	11.1	4.6	6.5	10.0	6.2	16.5	76.0	33.3	58.4	2.67
05	14.0	10.0	4.0	12.0	47.8	51.9	95.0	57.6	62.6	1.09
06	14.6	4.0	10.6	14.0	63.1	71.5	77.1	90.4	47.9	1.13
*12	14.9	5.2	9.7	15.0	40.2	13.8	77.8	86.7	4.0	0.34
09	15.4	10.0	5.4	14.0	5.0	42.9	75.0	95.0	48.8	8.58
11	16.0	4.5	11.5	13.0	70.0	90.4	42.5	95.0	70.7	1.29

*Subject recruited from outside diabetes clinic.

Table 12. Mean values for males and females: age, duration of diabetes, HbA_{1c} and anthropometric measurements.

	Males	**s	Range from	to	Females	s	Range from	to
Age (years)	12.2	2.56	8.0	15.7	11.6	3.19	7.0	16.0
Age at onset (years)	9.18	3.37	2.6	13.9	7.23	3.13	1.8	11.5
Duration (years)	2.9	2.93	0.2	9.0	4.40	3.42	0.3	10.0
HbA_{1c} (%)	11.7	2.0	8.0	14.3	12.3	1.78	9.0	15.0
*Height	54.1	21.34	24.6	94.8	53.1	30.10	5.0	95.0
*Weight	61.5	24.10	22.4	95.0	54.1	27.0	13.8	95.0
*SSF	81.6	13.50	58.3	95.0	67.1	23.68	19.0	95.0
*TSF	77.4	20.43	46.3	95.0	68.9	31.70	7.5	95.0
*MAMC	44.9	22.17	15.8	83.9	45.2	31.39	4.0	90.7
*Weight:height ratio	1.21	0.483	0.47	1.8	1.73	2.23	0.34	8.6

*Percentile values
**±Standard Deviation

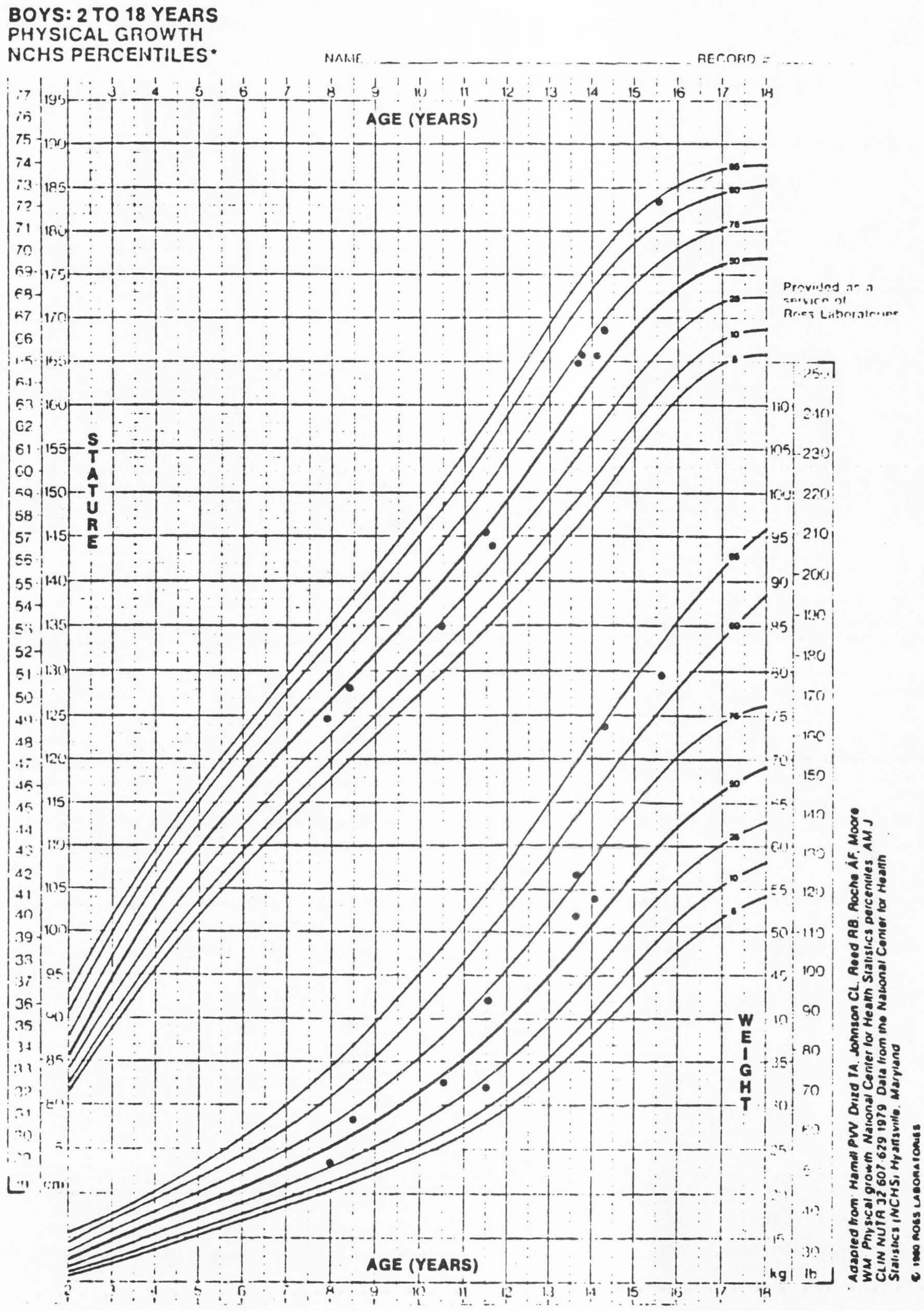

Figure 1. Individual height and weight percentiles of males in the IDDM study population.

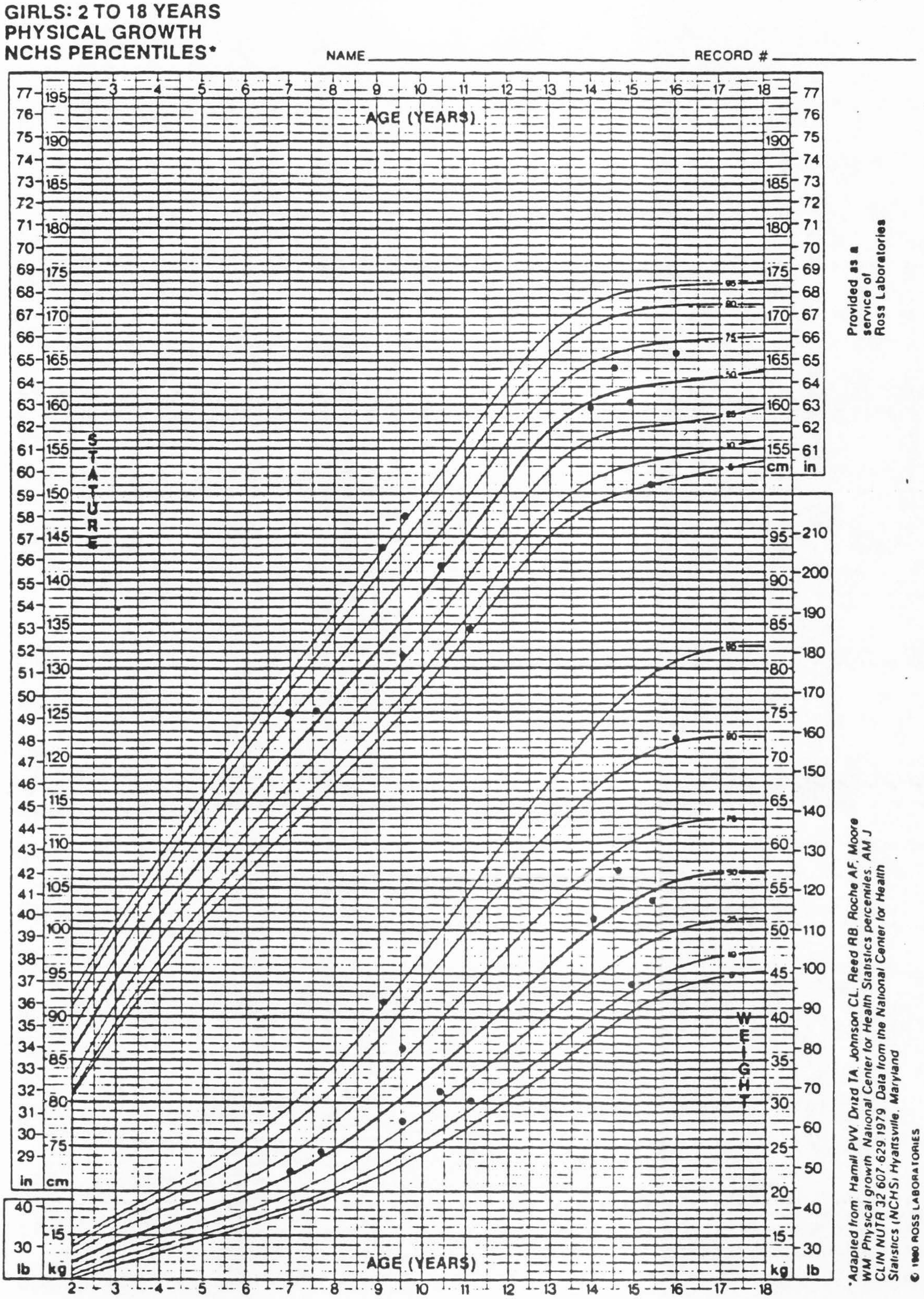

Figure 2. Individual height and weight percentiles of females in the IDDM study population.

percentile rank. No subjects fell below the fifth percentile for height for age.

Measurements between the 25th and 75th percentiles are likely to reflect normal growth, and between the 10th and 25th and the 75th and 90th "may or may not be normal, depending on previous and subsequent measurements, and on genetic and environmental factors affecting the child" (Hamill and Moore, 1976, page 22). It has been suggested that referral for medical evaluation may be indicated if children's percentile ranks are above 90 or below 10, especially if in excess of 95 or below five.

It must be considered that growth assessment is a screening, and not a diagnostic procedure. Although one male and two females ranked above the 90th percentile for age for height, it is unlikely that any abnormality is present. These subjects were probably just tall for age. They are "larger than 90 of every 100 U.S. subjects their age and sex" (Hamill and Moore, 1976, page 22). Two female subjects had height percentiles of 5.0 and 6.2. This information alone is not sufficient to judge these as cases of suboptimal height as genetic predisposition to shortness or tallness was not investigated in this study. Sterky (1967) had calculated parent-child height correlation after subjects had attained adult height, and was able to better substantiate disturbed growth. Further evaluation of these subjects is indicated, however, since ages at onset were both prior to pubertal onset, duration of disease was substantial (4.6 and 10 years) and HbA_{1c} values were 10.0 and 14.0 percent (Table 11). These factors have, in the past, been associated with height retardation (Wagner et al., 1942; Jackson and Kelly, 1946; Bergqvist, 1954; Sterky, 1967; Evans and Lister, 1970; Birkbeck, 1972; Jivani and Rayner, 1973; Tattersall and Pyke, 1973; Jackson et al., 1978; Schvaneveldt, 1980 and Mella, 1981). Also, since all male, less than 12 years of age fell below the 50th percentile for height (Figure 1), growth disturbance might be suspected. To substantiate this, parental height and individual longitudinal height data would need to be investigated. Jivani and Rayner (1973) and Jackson et al. (1978) had found reduced or delayed pubertal growth spurts mainly in males, and had felt that low level of diabetes control was a factor. This effect was not demonstrated in this study sample.

Weight and Weight:Height Percentile Ratio

Mean weight percentiles for age averaged 61.5 and 54.1 for males and females, respectively. Range was notably large for both sexes (the lowest and highest percentile values were 22.4 to 95.0, respectively, for males and 13.8 to 95.0, respectively, for females). Weight:height percentile ratios ranged from 0.34 to 8.58 for females, and from 0.47 to 1.84 for males. Values substantially above 1.5 might suggest overweight for height, but care must be taken when interpreting these values due to variability of somatotypes between individuals. Beal (1980) has stated that in general, weight-height ratios fail to distinguish between lean body mass and adipose tissue as components of weight. A muscular individual might appear overweight for height according to the ratio, but in reality, have little adipose tissue. Genetic influences and degree of maturity are also not taken into account by weight-height ratio indices. One female and one male had ratios less than 0.5, suggesting low weights for height. Factors to be considered might include poor control (resulting in substantial calories lost via the urine) or simply a recent spurt in height pending a resultant increase in weight. The female's HbA_{1c} value was 15.0 percent and the male's 10.3 percent. Although poor control and resultant glycosuria might be a factor in the low weights for heights, individual longitudinal data for these subjects would need to be carefully examined before any conclusions could be made.

It was worth noting that the female discussed here was the one subject recruited from outside the clinic via diabetes camp. Although this subject visited her family physician one to two times annually, and had learned home blood glucose monitoring techniques through a diabetes camp sponsored by the Utah affiliate of the American Diabetes Association, she did not visit diabetes clinic to receive the ongoing multidisciplinary approach to care that the other subjects received. It was suggested both to the clinic staff and to the subject and her parents that she might benefit from attending the PCMC diabetes clinic. Arrangements were made for the clinic staff to contact her family physician.

Two females' values for weight:height ratio were above 2.50. Overweight was apparent in these individuals. Wagner et al. (1942), Jackson and Kelly (1946), Knowles et al. (1965), and Evans and Lister (1970) all reported a tendency toward overweight in female diabetic subjects after the pubertal growth spurt. Jackson et al. (1978) has stressed the importance of adjustments of insulin dosage and caloric intake after the pubertal growth spurt is complete. With one exception, subjects with weight:height ratios either substantially below or above 1.0 had HbA_{1c} values greater than or equal to 10 percent (Tables 10 and 11). However, no relationship between metabolic control levels and weight was demonstrated in this sample.

SSF, TSF and MAMC. Percentile values for subscapular skinfold ranged from 19.0 to 95.0 for females and from 58.3 to 95.0 for males. Three males and two females ranked at or above the 95th percentile for this parameter. One male and three female subjects fell below the 50th percentile, but no subjects were less than the 10th. Mean SSF percentile values for males was 81.6 and for females, 67.1. These values indicate that as a group, the subjects had subcutaneous truncal fat stores comparable to or above the HES Cycle I and Cycle II control population. These findings were consistent with those of Evans and Lister (1970), who discovered a trend toward increased SSF over the control group norms. One female subject whose weight:height ratio was 0.34 had a SSF percentile value of 77.8. Though appearing lean by comparison of height and weight percentile values, the SSF value indicated substantial subcutaneous energy stores in the truncal region. SSF values are considered by some to be most reflective of total body fat (Tanner and Whitehouse, 1962).

Triceps skinfold percentile values ranged from 46.3 to 95.0 for males and 7.5 to 95.0 for females. One female subject fell below the 25th percentile for TSF. Mean percentile values (Table 12) which were derived from the HES Cycle II and Cycle III data (Frisancho, 1981), indicate that this sample in general, had subcutaneous fat stores at least comparable to those of the control population. It must be considered, however, that the back of the arm is often a site for insulin injection. As a result, hypertrophy or atrophy may occur, and TSF measurements could be distorted. It was for this reason that SSF measurements were also obtained.

Mean MAMC percentiles for males and females were 44.9 and 45.2, respectively. As shown in Tables 10 and 11, percentile values ranged from 15.8 to 83.9 for males and from 4.0 to 90.7 for females. Four females fell below the 10th percentile while no males' values were less than 15. Half of all males and five of 12 females were below the 50th percentile rank for this paremeter. Though MAMC is considered to be a sensitive indicator of protein status (Grant, 1979) genetic factors and level of physical activity may also influence this measurement. Physical activity patterns were not observed in this study, and malnutrition is unlikely in this group of subjects (only one of the four subjects with MAMC percentile values below 10 had a kcalorie intake below the RDA, and protein intake was more than adequate for the entire group). MAMC has not been reported in the literature as part of growth assessment of subjects with IDDM although Sterky (1967) suspected reduced muscle mass in male subjects based on weight-height comparison. Although all subjects in this study with MAMC percentile values less than 10 had HbA_{1c} values greater than 10 percent, statistical analysis revealed no significant relationship between these two variables. It was notable that all males below 12 years, all of whom were below the 50th percentile rank for height also did not exceed the 40th percentile for MAMC. Insulin injection sites would have influenced this measurement. The overall distribution, however, indicate that this sample had MAMC values that reflect muscle protein reserves similar to the HES Cycle II and Cycle III control population.

Summary of Anthropometry

The study sample appeared to have distributions of the studied growth parameters similar to those of the HES Cycles II and III and HANES control populations. Though two and four female subjects were below the 10th percentile ranks for height and MAMC, respectively, and all males less than 12 years of age fell below the 50th percentile for height, genetic influences, individual medical evaluation and longitudinal growth data on these individuals would have to be considered before any growth abnormality could be documented. Two females (11 and 15 years of age) were overweight for height.

Hemoglobin A_{1c}

Glycosylated hemoglobin values averaged 11.7 percent for males and 12.3 percent for females (Table 12). No difference between means for males and females 12-16 years of age was determined at $\alpha = .05$ level of significance. Females' values ranged from 9.0 to 15 percent, while males' ranged from 8.0 to 14.3 percent.

There is no one widely acknowledged HbA_{1c} value above which is thought to be unacceptable. Nathan (1983) has suggested evaluation of current regimen and of compliance when HbA_{1c} values exceed 11.5 percent. Five males and nine females had values above this level.

Goldstein et al. (1982) encourage levels below nine percent but warn that HbA_{1c} values reflective of normal blood glucose levels are not realistic or desirable due to the risk of serious symptomatic hypoglycemia. Gabbay and Whitehouse (1981) stress that each patient be considered individually since different factors (age at onset sex and duration of disease) affect glycosylated hemoglobin levels.

Effect of HbA_{1c} on Growth Parameters

Results of simple linear regression (Appendix I) show that HbA_{1c} was of little value as a predictor of height, weight, TSF, SSF, MAMC and weight:height percentile ratio. Corresponding coefficients of determination indicate that little, if any, variability in the growth parameters can be accounted for by the regression equations. Boyd and Kantrow (1928), Jackson and Kelly (1946), Bergqvist (1954) and Jackson et al. (1978) all reported an association between short stature and lower levels of metabolic control. Although Birkbeck (1972), Jivani and Rayner (1973) and Schvaneveldt (1980) suspected short stature, they found no correlation between stature and level of metabolic control. The current study also failed to demonstrate any relationship between growth parameters and level of metabolic control.

Effect of Age at Onset on HbA_{1c} Levels

Results of linear regression analysis with corresponding coefficients of determination (Appendix E) show no evidence of a linear relationship between age at onset and HbA_{1c} levels for this study sample. Individual information for male and female subjects is portrayed in Tables 10 and 11. Gabbay and Whitehouse (1981) reported substantially higher mean HbA_{1c} levels for groups of children (sample size was not stated) whose onset was during early childhood than for groups diagnosed in their teens. This was most probably due to the absence of endogenous insulin in the younger diabetic, which would result in poorer metabolic control than that attained with newly diagnosed teens, who often have some beta cell action for a number of months, or even years, after diagnosis. This phenomenon was not demonstrated in this study.

Age at Onset and Duration of Diabetes

Mean ages at onset and duration of diabetes are shown in Table 12, and individual subject data shown in Tables 10 and 11. The study sample included subjects who had had diabetes for just a few months as well as those who were diagnosed as toddlers with duration up to 10 years.

Wagner, White and Bogan (1942) reported an association between short stature and both early age of onset and longer duration of disease. Moderate height retardation was found by Evans and Lister (1970) in both males and females whose duration of diabetes was greater than six years. Tattersall and Pyke (1973) reported retarded growth and development in monozygotic twins with IDDM when onset of the disease was prior to the pubertal growth spurt.

Regression equations (Appendices E and F) demonstrate that in this study, no evidence of linear relationships between: 1) age at onset and growth parameters or HbA_{1c}, and 2) duration of diabetes and growth parameters or HbA_{1c}. Coefficients of determination indicate that little, if any, variability in growth parameters or HbA_{1c} values was explained by the regression equations. The largest r^2 values from this analysis were for duration as a predictor of SSF in females (.426) and for HbA_{1c} as a predictor of TSF in females (.400). Higher r^2 values would be needed to substantiate any practically important linear relationship between duration and HbA_{1c} on subcutaneous fat stores in females. This study demonstrated no significant effect of age at onset or duration on growth parameters or HbA_{1c} levels. Individual HbA_{1c} values are plotted against duration of diabetes in Figure 3.

Dietary Intake Data

Energy

Energy intake, expressed as kilocalories per kilogram body weight, fell below the standard for four males and nine females. Mean percentages of the RDA (adjusted for individuals) were 95.5 and 86.1 for males and females, respectively (Tables 13 and 14). Males' intake ranged from 57.9 to 128.7 percent of the RDA while females ranged from 65.9 to 132.6 percent of the RDA for energy. Distribution of macronutrient contribution to total calories is depicted in Tables 15 and 16.

Factors that may have contributed to the appearance of energy intakes below recommendations include a lower than usual intake of energy on one or more of the days surveyed, and/or failure of the subjects to record all foods or eating occasions. Since this was a

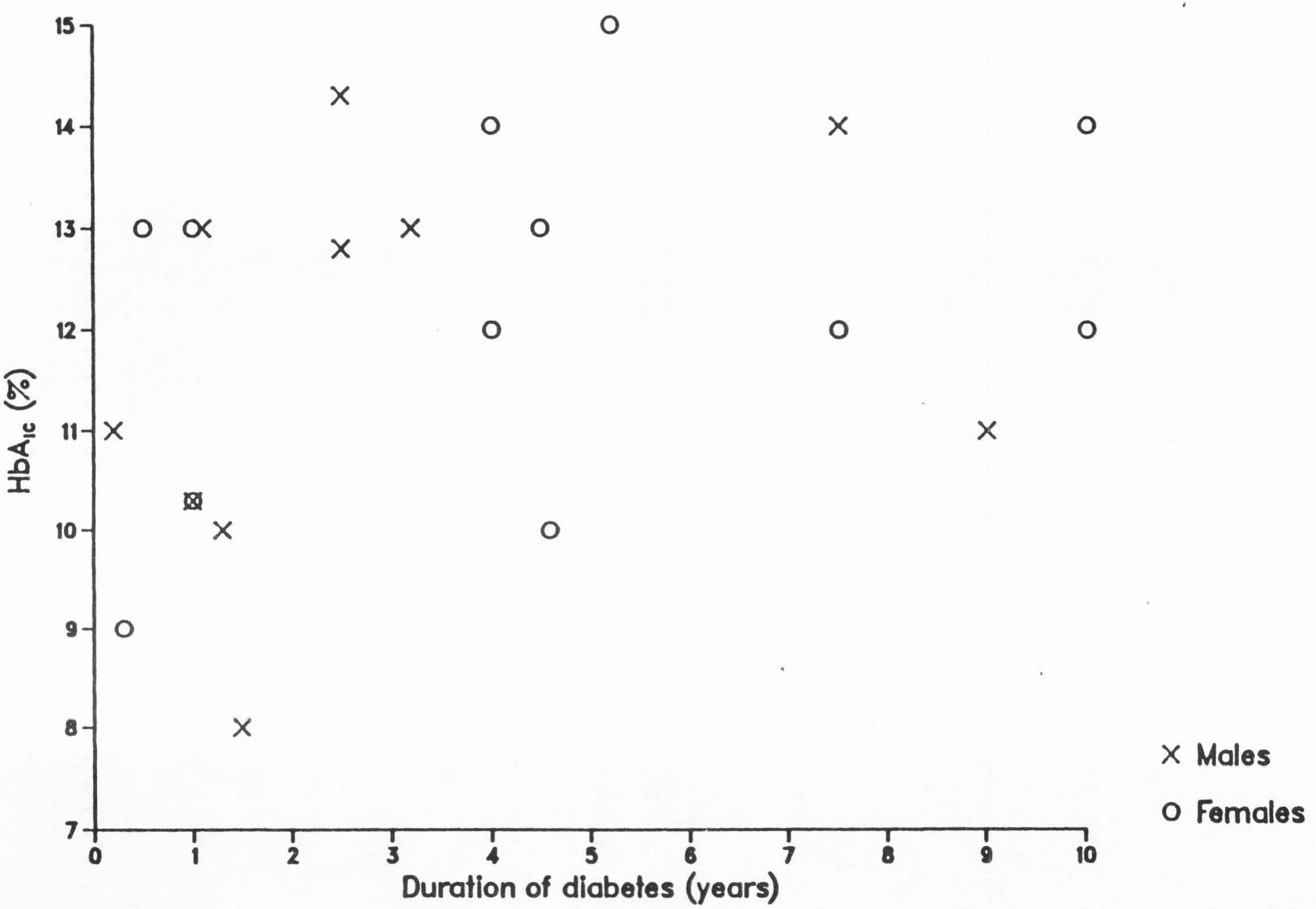

Figure 3. Scatter diagram of HbA_{1c} and duration of diabetes: males and females.

Table 13. Energy intake of 7-15 year-old males with IDDM expressed as percentage of 1980 RDA.

Subject	Age (years)	*RDA	*Intake	Percentage of Standard
01	8.0	85.7	90.2	105.3
02	10.6	85.7	93.5	109.1
03	13.7	60.0	53.0	88.4
04	13.6	60.0	69.5	115.8
05	11.6	60.0	68.0	113.3
06	11.5	60.0	77.2	128.7
07	8.5	85.7	89.7	104.3
08	14.1	60.0	44.3	73.8
09	15.7	42.4	24.3	57.3
10	14.3	60.0	35.6	59.3
				mean = 95.5

*Expressed as kilocalories per kilogram body weight.

Table 14. Energy intake of 7-16 year-old females with IDDM expressed as percentage of 1980 RDA.

Subject	Age (years)	*RDA	*Intake	Percentage of standard
11	11.1	47.8	63.4	132.6
12	9.3	85.7	64.6	75.4
13	7.6	85.7	68.7	80.2
14	9.6	85.7	69.7	81.3
15	14.0	47.8	31.5	65.9
16	14.6	47.8	42.6	89.1
17	9.5	85.7	65.9	76.9
18	10.4	85.7	78.7	91.8
19	15.4	38.2	26.3	68.9
20	7.0	85.7	91.0	106.2
21	16.0	38.2	27.3	71.5
22	14.9	38.2	47.1	123.3
				mean = 86.1

*Expressed as calories per kilogram body weight.

Table 15. *Mean percentages of 7-16 year-old diabetic individuals' intake of calories supplied by protein, fat and carbohydrate.

Sex	Protein (%)	*s.d.	range from to	Fat (%)	s.d.	range from to	Carbohydrate (%)	s.d.	range from to
Males	17.7	2.0	14.5 - 22	41.2	6.1	34.1 - 55.3	42.0	6.4	27.7 - 49.8
Females	17.0	2.0	13.0 - 20.2	36.3	4.9	28.8 - 46.0	48.5	4.4	42.0 - 55.9
Males and Females	17.3	2.0	13.0 - 22.0	38.6	5.9	28.8 - 55.3	45.5	6.4	27.7 - 55.9

*±standard deviation.

Table 16. *Percentage of total calories supplied by each of the major nutrients: 7-16 year-old individuals with IDDM, by age subgroup

Sex	Age (years)	n	Protein (%)	Fat (%)	CHO (%)
Males	7-8	2	16.7	38.5	46.2
	9-11	3	16.5	40.8	43.9
	12-14	4	19.1	43.9	37.4
	15	1	18.4	30.9	50.7
Females	7-8	2	16.0	32.7	54.1
	9-11	5	16.3	39.0	46.9
	12-14	3	17.9	35.6	47.3
	15-16	2	17.7	35.6	48.0
			**12-20	28-38	50-60

*Percentages may not add up to 100 due to rounding.

**Recommendations by the American Diabetes Association (1979).

diabetic sample and people with diabetes are generally discouraged from eating between specified meal and snack times (with the exception of treatment for hypoglycemia), it is possible that eating episodes were not recorded. A decrease in activity level may have resulted in a lower than usual intake, but this was unlikely since subjects were encouraged to record food intake on days that were most typical of their activity and food consumption patterns. Tables 10 and 11 portray data that indicate low weights (substantially below a weight:height percentile ratio of one) for four individuals, but the remainder of the group appeared to be at or above height-appropriate weight percentiles. Two females exceeded weight:height percentile ratios of two, indicating overweight. Both triceps and subscapular skinfold thicknesses fell below the tenth percentile for one female subject only. It is therefore unlikely that the majority of these subjects were consuming inadequate quantities of energy over periods of time, as anthropometry is consistent with adequate energy stores. Since longitudinal examination of anthropometric parameters were not undertaken in this study, however, it is not known if subjects have had any weight changes over time. It was interesting to note that reports from both the NFCS (1977-78) and the NHANES II data showed caloric consumption to average approximately 12 to 15 percent less than the RDA for energy for the six to 18 year old groups. A comparison of energy intakes of the IDDM study group with those from the NFCS (1977-78) and the NHANES II survey are portrayed in Figure 4. With the exception of nine to18 year-old males, the IDDM study group appeared to have consumed somewhat more energy, on the average, than the national survey sample.

Ranges of energy intake (calculated as the larger number of kilocalories consumed minus the smaller number) over the three-days studied for males were as low as 51 kcalories and as high as 1808 kcalories (Appendix M). Females low and high range values were 31 kcalories and 125 kcalories, respectively.

Protein

No subjects consumed less than the RDA for age and sex for protein (Tables 17 and 18). Mean intake for males was 260.8 percent of the standard while females consumed 210.0 percent of the standard. Males averaged 17.7 percent of total calories as protein while females consumed 17.0 percent of total energy as protein. Ranges are shown in Table 15. The American Diabetes Association (1979) has recommended that 12-20 percent of total energy be supplied by protein. The sample population did not consume below 12 percent of total energy as protein, but tended more toward the upper limits of the American Diabetes Association recommendations. The majority of protein consumed came from meats, milk, cheese and poultry sources. Protein intakes expressed as grams protein per 1000 kilocalories for the IDDM study group and the two national survey samples are portrayed in Figure 5. The IDDM study group appeared to consume greater amounts of protein than either of the two survey samples. Nutrition counseling for the diabetic group was probably a factor which emphasized protein-rich foods in the diet plan, and led to higher mean protein intakes in the diabetic study population. No conclusions can be drawn

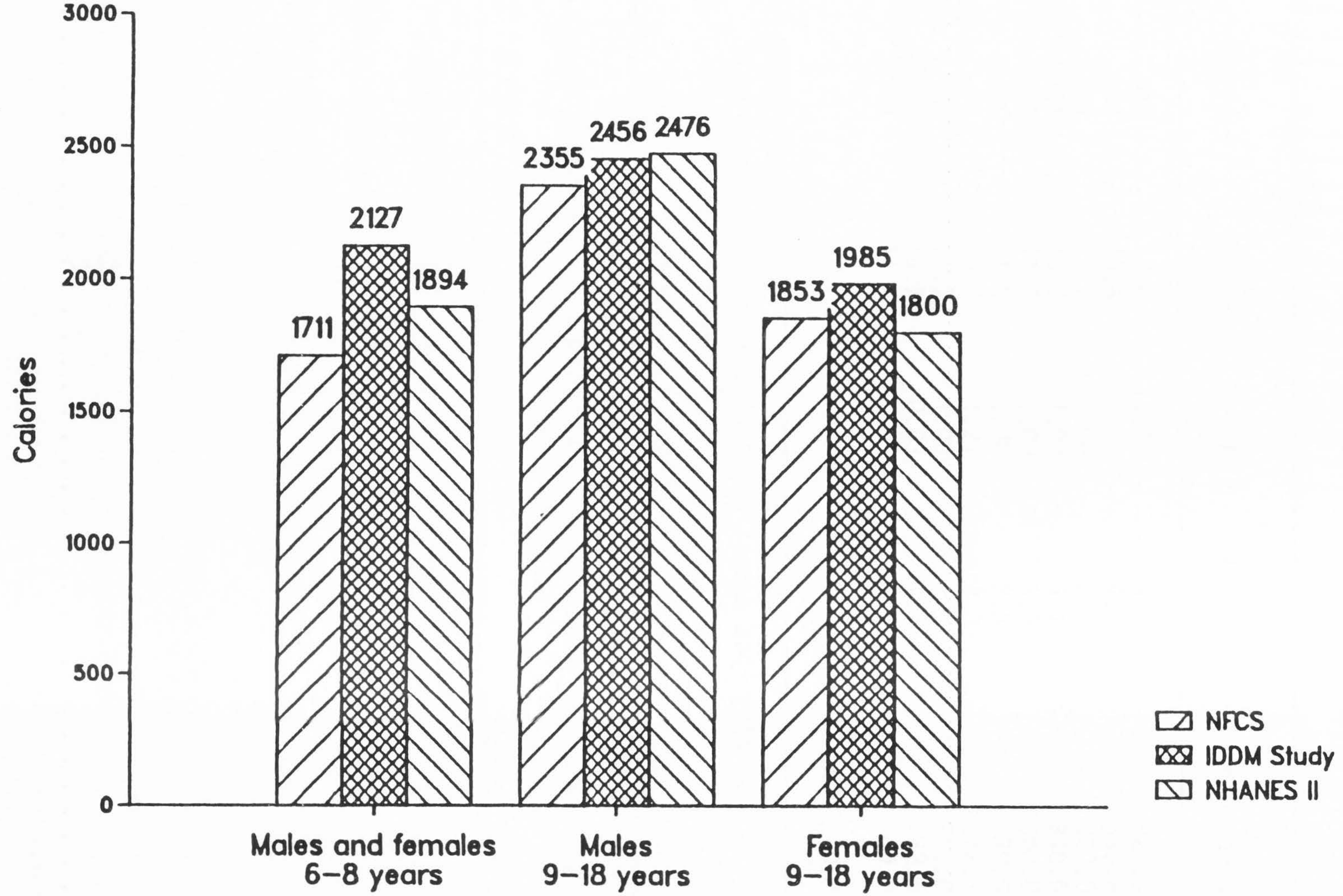

Figure 4. Mean intake of calories: NFCS (1977-78), IDDM study population and NHANES II (1976-80).

Table 17. Protein intake of 7-15 year-old males with IDDM expressed as percentage of 1980 RDA.

Subject	Age (years)	*RDA	*Intake	Percentage of standard
01	8.0	1.21	3.9	322.3
02	10.6	1.21	4.0	330.6
03	13.7	1.00	2.3	230.0
04	13.6	1.00	3.4	340.0
05	11.6	1.00	3.0	300.0
06	11.5	1.00	2.8	280.0
07	8.5	1.21	3.3	272.7
08	14.1	1.00	2.4	240.0
09	15.7	0.83	1.1	132.5
10	14.3	1.0	1.6	160.0
				mean = 260.8

*Expressed as grams protein per kilogram body weight.

Table 18. Protein intake of 7-16 year-old females with IDDM expressed as percentage of 1980 RDA.

Subject	Age (years)	*RDA	*Intake	Percentage of standard
11	11.1	1.00	3.1	310.0
12	9.3	1.21	2.1	173.6
13	7.6	1.21	2.9	239.7
14	9.6	1.21	2.9	239.7
15	14.0	1.00	1.6	160.0
16	14.6	1.00	1.8	180.0
17	9.5	1.21	2.8	231.4
18	10.4	1.21	3.3	272.7
19	15.4	0.84	0.85	101.2
20	7.0	1.21	3.4	281.0
21	16.0	0.84	1.1	131.0
22	14.9	1.0	2.0	200.0
				mean = 210

*Expressed as grams protein per kilogram body weight.

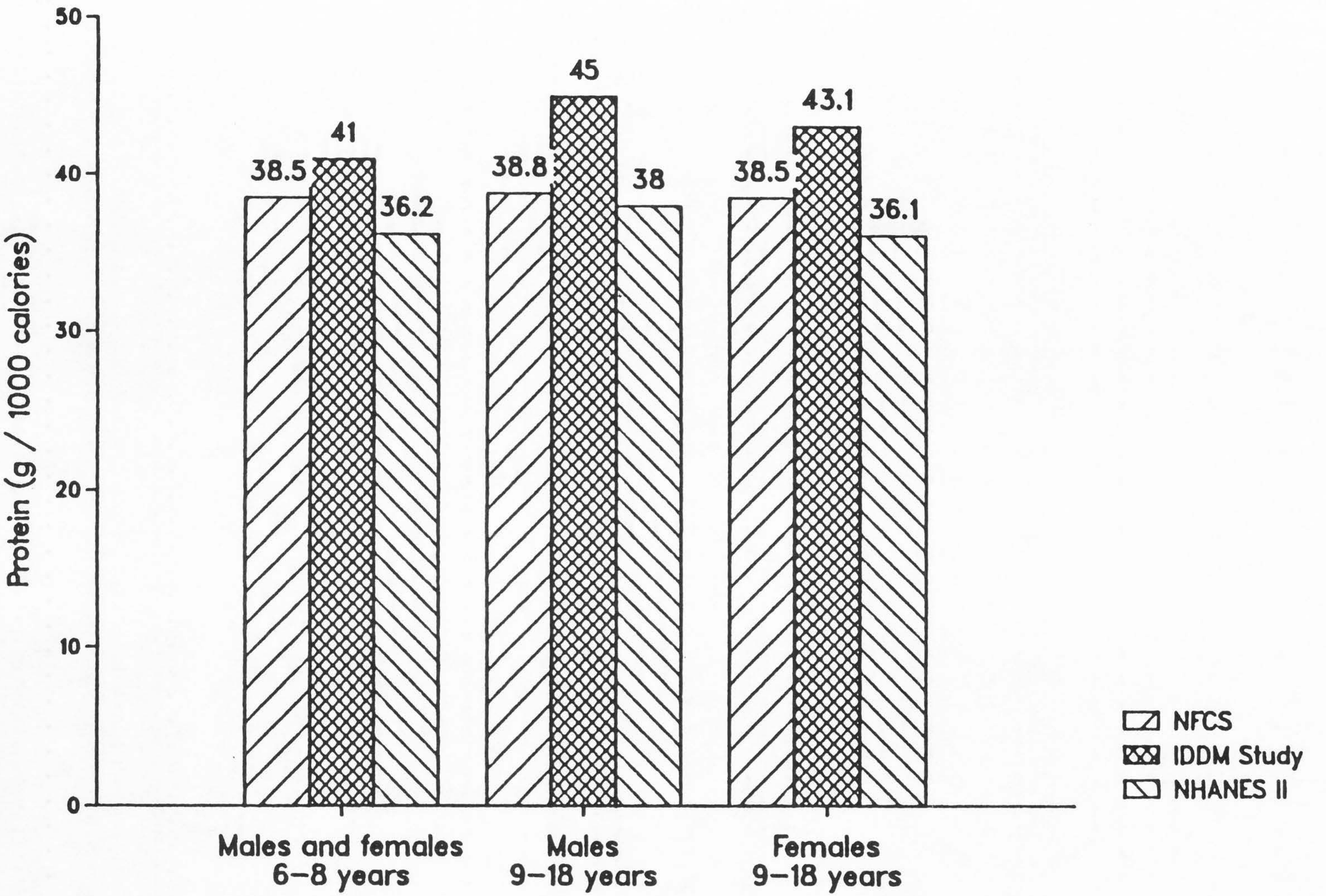

Figure 5. Mean intake of protein per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

from this however, since the study group was substantially smaller than the national survey samples.

Fat. The fat consumed contained substantial quantities of saturated fatty acids and no subjects' intakes were shown to be characterized by a P:S ratio greater than or equal to one (Table 19). No difference between means of males' and females' P:S ratios was determined at α=.05 level of significance. Individual raw data used in calculation of P:S ratios appear in Appendix O.

Mean cholesterol intakes for males and females were 582.1 and 353 milligrams, respectivley. A T-test between means determined amounts of total cholesterol to be unequal for males and females at the α=.05 level of significance. However, since males consumed more calories overall than females, cholesterol expressed as milligrams per 1000 calories was observed, and no difference between males' and females' means were demonstrated at the α=.05 level of significance when a T-test was employed. Skyler (1983) has recommended intakes of cholesterol of no greater than 400 milligrams per day. Thirteen subjects (59 percent) in this study exceeded this recommendation.

Fat intakes for males ranged from 34.1 to 55.3 percent of total energy while females' intakes ranged from 28.8 to 46.0 percent of total calories. Males and females combined averaged 38.6 ± 5.9 percent of total energy intake as fat (Table 15). Nine to eleven year-old and 12-14 year-old males and nine to eleven year-old females consumed the greater proportions of total energy as fat. The study group consumed fat in proportions of total calories similar to those reflected by NFCS (1977-78) and NHANES II (1976-80) survey data for

Table 19. P:S ratio and cholesterol intakes of male and female subjects with IDDM.

	P:S Ratio		Total Cholesterol (mg)		Cholesterol per 1000 kcal (mg)	
	mean	s*	mean	s	mean	s
Males	0.2930	0.105	582	232.9	218	81.3
Females	0.3266	0.218	353	118.8	179	77.1

*standard deviation

six to 18 year-old individuals (Table 20). The American Diabetes Association (1979) has recommended that 12 to 20 percent of total energy should come from protein, 50-60 percent from carbohydrates and that the difference should come from fat (20 to 38 percent of total energy intake). Ten of the 22 subjects fell within this range. All other subjects consumed greater than 38 percent of total energy as fat. The U.S. Dietary Goals of the Senate Select Committee (1977) suggest fat intakes which supply no more than 35 percent of total energy. The major concern underlying these recommendations for caution regarding fat intake (saturated, as well as total) is that diabetic individuals are at increased risk for atherosclerosis and thus, for death from cardiovascular disease (Burgess, 1982). Though it is not certain that dietary saturated fat and cholesterol restriction and replacement with polyunsaturates will delay atherogenesis, "it is a reasonable expectation" (American Diabetes Association, 1979). Diabetic individuals should therefore restrict foods containing substantial amounts of saturated fatty acids and cholesterol.

The study sample consumed fat in proportions of total energy that were higher than generally recommended. The high animal protien intake of this group of youth most likely contributed the majority of this fat, saturated fat and cholesterol to the diet. Cholesterol intakes for males exceeded the recommendations of no more than 400 mg of cholesterol daily (Skyler, 1983), as well as amounts consumed by data from NHANES II for the same age groups (mean values for males in the study group was 582 milligrams per day and for females 353

Table 20. Mean percentage of total energy supplied by fat.

Sex	NFCS (%)	NHANES II (%)	IDDM Study Group (%)
Males	39.2	36.6	41.2
Females	38.5	36.7	36.3

milligrams per day). In addition, mean P:S ratios of this group indicate consumption of large quantities of saturated fatty acids and relatively small quantities of polyunsaturates. A P:S ratio of at least 1.0 is recommended for individuals with diabetes (Skyler, 1983). No subjects in this group met this recommendation. Since the subjects in this group were young, it is probable that complications of diabetes would have their onset at earlier stages of life than diabetics who are diagnosed as adults. Thus, it would be wise to emphasize reduction of saturated fats, cholesterol and total fat overall. It is known that atherogenesis begins as early as infancy (and certainly by childhood) and if dietary fats and cholesterol are indeed associated with elevated lipid profiles, this group would benefit from modification of their lipid consumption patterns.

Carbohydrate

Tables 15 and 16 portray proportions of carbohydrate in terms of total calories for the IDDM study group. Males' mean percentage of total energy as carbohydrate was 42.0 percent while females consumed approximately 48.5 percent. Male subjects consumed up to 49.8 percent of energy as carbohydrate while four females exceeded 50 percent. No subjects exceeded 56 percent. Ranges of percentage of total calories from carbohydrate were 27.7 to 49.8 percent for males and 42.0 to 55.9 for females. Nine individuals consumed less than 45 percent of total energy as carbohydrate. Subjects generally consumed lower proportions of total energy as carbohydrate than the recommended 50 to 60 percent (American Diabetes Association, 1979). Brunzell et al. (1971) had found enhanced ability to regulate glucose clearance in well-controlled diabetic individuals following high-carbohydrate diets, but no benefit appeared to occur for poorly controlled subjects. Nuttall (1983) has stated that, based on currently available evidence, individuals with diabetes can ingest diets varying widely in macronutrient composition without a serious impact on blood glucose control or total insulin requirements. There is little evidence to date to acutally prove superiority of one dietary regimen over another with regard to life expectancy or blood glucose control, but increasing the carbohydrate content of the diets of these young diabetics would serve to displace protein and fat components. The diets would then more closely approximate the current recommendations.

A profile of added sugar intakes of the IDDM study group is depicted in Table 21. Males and females combined averaged 7.95 ± 4.7 percent of total carbohydrate and 3.6 ± 2.2 percent of total calories as added sugars. This value reflects added sucrose as well as fructose, corn syrup solids, etc. The type and amounts of sugar could not designated by the nutrient analysis program/data base. The Dietary Goals for the U.S. (1977) suggest consumption of no more than 10 percent of total calories from refined sugars. Mean intakes of this group fell well below this level, but the implications of inclusion of refined sugar in the diets of diabetic individuals are not known. No specific recommendations regarding refiendk sugar intake in diabetes are available.

Though current recommendations by the diabetes community continue to include avoidance of simple sugars (especially glucose and glucose-containing disaccharides) judgement regarding the

Table 21. Added sugar intake of the IDDM study population.

	% Carbohydrate as Added Sugar	Range		% Total Calories as Added Sugar	Range	
		From	To		From	To
Males	6.6 ± 4.7	2.02	15.4	2.79 ± 2.0	0.3	5.8
Females	9.1 ± 4.4	1.15	15.7	4.35 ± 2.2	0.6	6.8

appropriateness of added sugar in the diabetic's diet must not be made without considering a number of issues. First, many professionals believe that inclusion of some sweetness in the diet leads to better overall compliance with the diabetes care regimen. In addition, no one artificial sweetener has been shown to be completely without some problems with palatability and/or safety. A third consideration is that while sucrose is a glucose-containing dissaccharide, Jenkins et al. (1981) has demonstrated that glycemic response to sucrose is no greater than that of white spaghetti, peas, sweet corn or bran cereals, all of which are "allowed" in diabetic diet plans. Cooked potatoes, rice and breads elicit glycemic responses that are similar to that of glucose, or only modestly less (Crapo et al., 1976). There is little scientific data to support the notion that sucrose and other refined sugars have no place in the diets of diabetic individuals (Talbot and Fisher, 1978; Nuttall and Gannon, 1981; Nuttall, 1983). Though data on glycemic response to carbohydrates remain in the initial stages of intrepretation, further research regarding physiologic response to foods and combinations of foods might enable people with diabetes to liberalize their consumption of simple sugars without compromising glycemic control.

Vitamins

Consumption of thiamin, riboflavin, niacin and vitamin B_{12} met or exceeded the RDA for all subjects. Except for one female subject who consumed 88 percent of the standard for vitamin C all subjects met or exceeded the RDA for this nutrient. Table 22 shows mean nutrient intakes below the RDA for age subgroups by sex. All but three

Table 22. Nutrient intakes below 1980 RDA for 7-16 year-old youths with IDDM based on 3-day dietary intake records.

Sex	Age range (years)	*n	90-99% RDA	80-89% RDA	70-79% RDA	Below 70% RDA
Males	7-8	2		zinc (88.0%)		
	9-11	3	folate (92.7%)	zinc (87.5%)		
	12-14	4		folate (82.5%)		
	15	1		magnesium (81.8%) zinc (82.1%) vit. B_6 (86.5%) vit. A (88.5%)	folate (74.1%)	iron (25.6%)
Females	7-8	2				
	9-11	5				
	12-14	3	iron (90%)	folate (86.8%)	zinc (73.6%)	
	15-16	2	calcium (94.8%)		iron (76%)	zinc (65.9%) folate (63.2%)

*n = number of subjects.

subjects met or exceeded the standard for vitamin A, but none consumed below 70 percent of the RDA for this nutrient. Approximately one-third of all subjects consumed amounts of vitamin B_6 below the standard. Half of all males and two-thirds of all females consumed substandard amounts of folacin.

This sample population generally consumed adequate amounts of all vitamins studied with the exception of folacin and vitamin B_6. Dietary intake of the subjects may not have included substantial sources of vitamin B_6 (poultry, fish, meats, legumes, vegetables and whole-grain cereals) or of folate (green, leafy vegetables, fruits, liver, etc.) on the days surveyed. Whether or not this is a chronic situation would have to be determined by longer term dietary studies and/or biochemical profiles. It would probably be of benefit to stress the inclusion of folate and B_6-rich foods in the diets of these young subjects. Before concluding that these youth are at risk for vitamin deficiency states, the status of analytical methodology for these nutrients must also be considered. As shown in Table 9, vitamin B_6 is characterized by "tentatively acceptable" analysis methodology (Stewart, 1982). These methods are not considered to be "sufficient" or "substantial." Folacin is classified as having "limited analytical methodology." Therefore, values for these nutrients which were used in the NUTREDFO data base may not reflect actual nutrient content of these foods.

Tables 23 and 24 show nutrient intakes below the RDA from NFCS and NHANES II data, respectively. The NHANES II survey did not include vitamins B_6 and B_{12} or magnesium data. Neither of the studies

Table 23. Nutrient intakes below 1980 Recommended Dietary Allowaces - USDA Nationwide Food Consumption Survey data. Average intake as percentage of 1980 RDA.

Sex	Age Range	90-99% RDA	80-89% RDA	70-79% RDA	Below 70% RDA
Males and females	6-8 years	magnesium vitamin B_6			
Males	9-11 years	calcium vitamin B_6	magnesium		
	12-14 years	calcium vitamin B_6	iron magnesium		
	15-18 years	calcium, iron vitamin B_6		magnesium	
Females	9-11 years	iron	calcium magnesium vitamin B_6		
	12-14 years	phosphorus		calcium magnesium vitamin B_6	iron
	15-18 years	phosphorous		magnesium	vitamin B_6 iron calcium

Source: USDA Nationwide Food Consumption Survey, 48 states, Spring, 1977 (Preliminary Report No. 2).

Table 24. Nutrient intakes below 1980 Recommended Dietary Allowances for 6-17 year-old subjects from NHANES II data.

Sex	Age Range (years)	90-99% RDA	80-89% RDA	70-79% RDA	Below 70% RDA
Males	6-8				
	9-11				
	12-14	calcium (98%)	iron (88%)		
	15-18	iron (96.9%)			
Females	6-8				
	9-11	calcium (99.4%)	iron (88%)		
	12-14	phosphorous (94.2%) vitamin A (99%)		calcium (71.6%)	iron (59.8%)
	15-18	vitamin A (90.9%) thiamin (98.2%)	phosphorous (88.4%)		calcium (63.7%) iron (54.8%)

Sources: 1) Dietary Intake Source Data: United States, 1976-80. The Second National Health and Nutrition Examination Survey (NHANES II).
2) Adaptation of 1980 RDA for use with the USDA Nationwide Food Consumption Survey 1977-78.

considered folacin intake. The NFCS (1977-78) survey data shows vitamin B_6 intake consistently below the RDA. Six to eight year-old males and females, and nine to 18 year-old males consumed 90 to 99 percent of the standard, while 15 to 18 year-old females' intakes fell below 70 percent of the RDA. It appears that the IDDM study sample consumed more vitamin B_6 and B_{12}, on the average, than the NFCS subjects of matching age groups (Table 25). It is possible that nutritional supervision of diabetic subjects might have resulted in greater nutrient density of the diet. Jackson et al. (1978) have proposed that diets of diabetic children are "superior" to the non-diabetic population as a result of the continuous attention given to their dietary intakes. Figures six through 10 portray comparisons of mean intakes per 1000 kcalories of vitamins A, thiamin, riboflavin, niacin and vitamin C of the study group and of the two national survey populations for corresponding age groups. Mean intakes of the study group were consistently higher than those from the national survey samples. Since the study sample was so much smaller than those used for the national surveys, no definite conclusions could be made, but this study suggests that nutrient density of closely monitored diabetic youths' diets may be substantially higher than the non-diabetic population.

Minerals

All individuals consumed phosphorous in amounts greater than or equal to the standards. All but two subjects had intakes of calcium at or above 100 percent of the RDA for age and sex. Seven subjects took in less than the standard for magnesium though none fell below

Table 25. Mean intake of vitamins B_6 and B_{12} of the IDDM study group and NFCS (1977-78) subjects.

Sex	Age (years)	IDDM Study Sample B_6 (mg)		NFCS (1977-78) B_6 (mg)	
		B_6 (mg)	B_{12} (mcg)	B_6 (mg)	B_{12} (mcg)
Males and Females	6-8	2.02	5.89	1.35	4.24
Males	9-11	1.96	5.88	1.56	4.86
	12-14	2.42	10.67	1.78	5.24
	15-18	*1.73	5.44	1.96	5.77
Females	9-11	2.20	4.54	1.43	3.86
	12-14	1.94	5.86	1.35	4.02
	15-18	1.72	5.31	1.30	3.66

*One subject only.

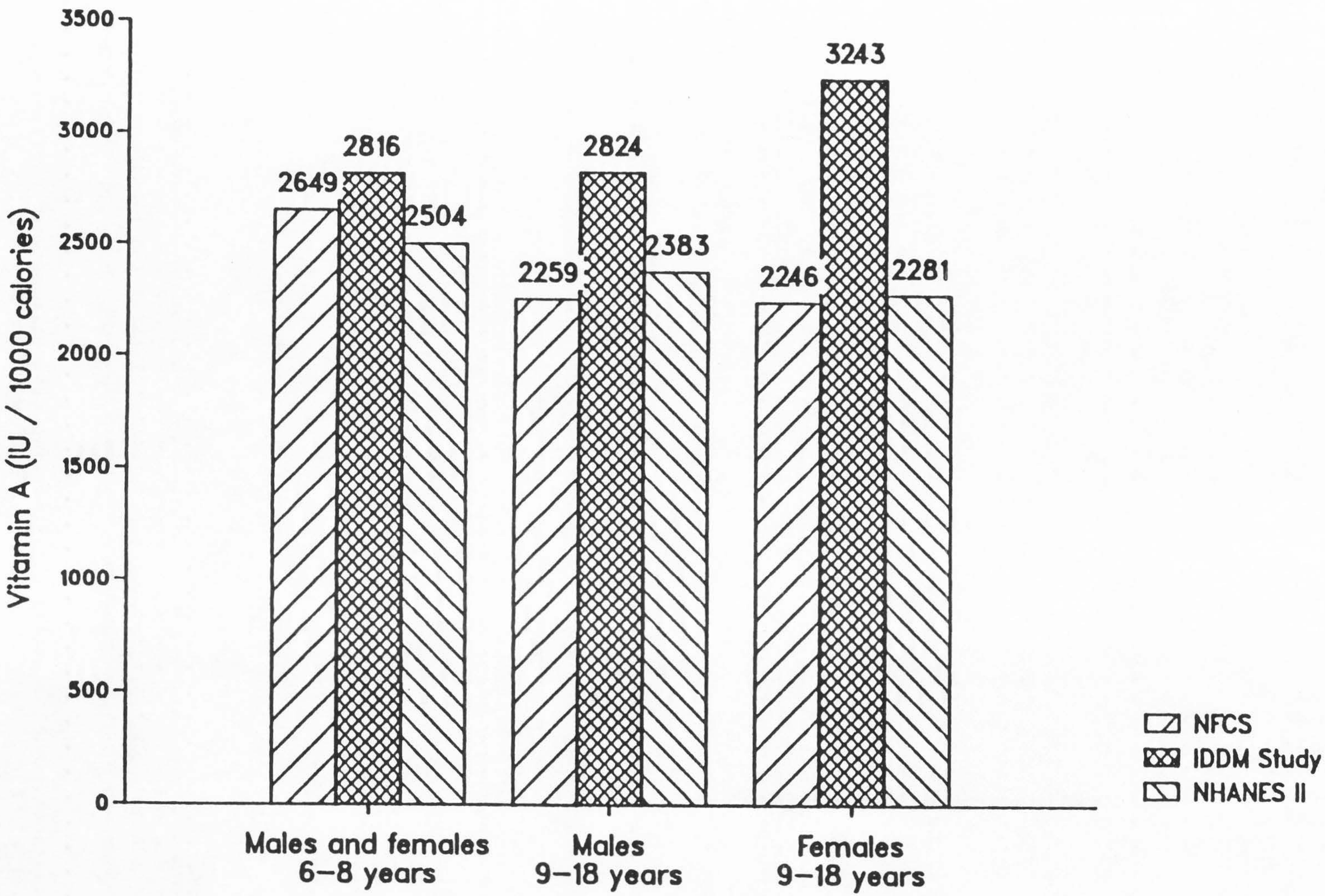

Figure 6. Mean intakes of vitamin A per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

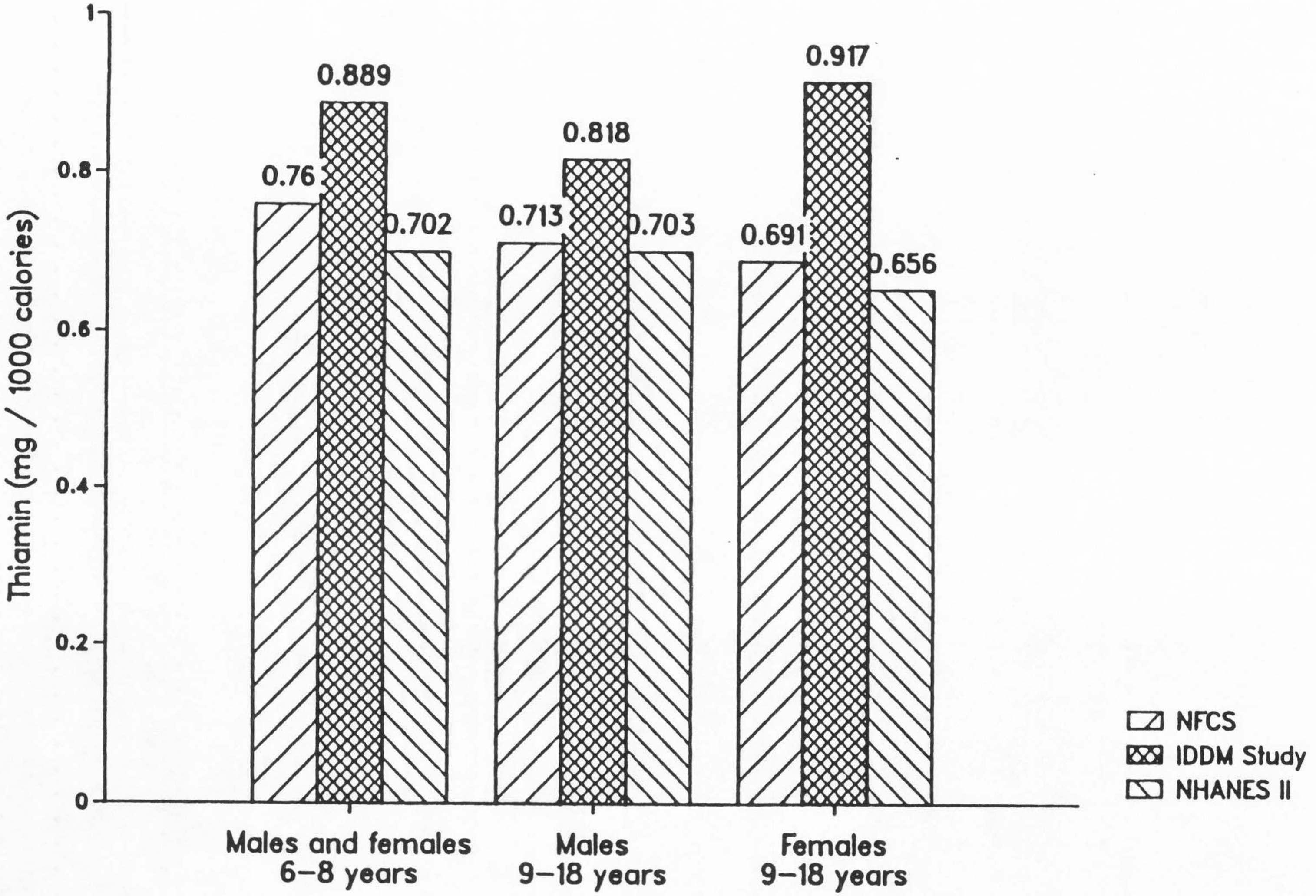

Figure 7. Mean intakes of thiamin per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

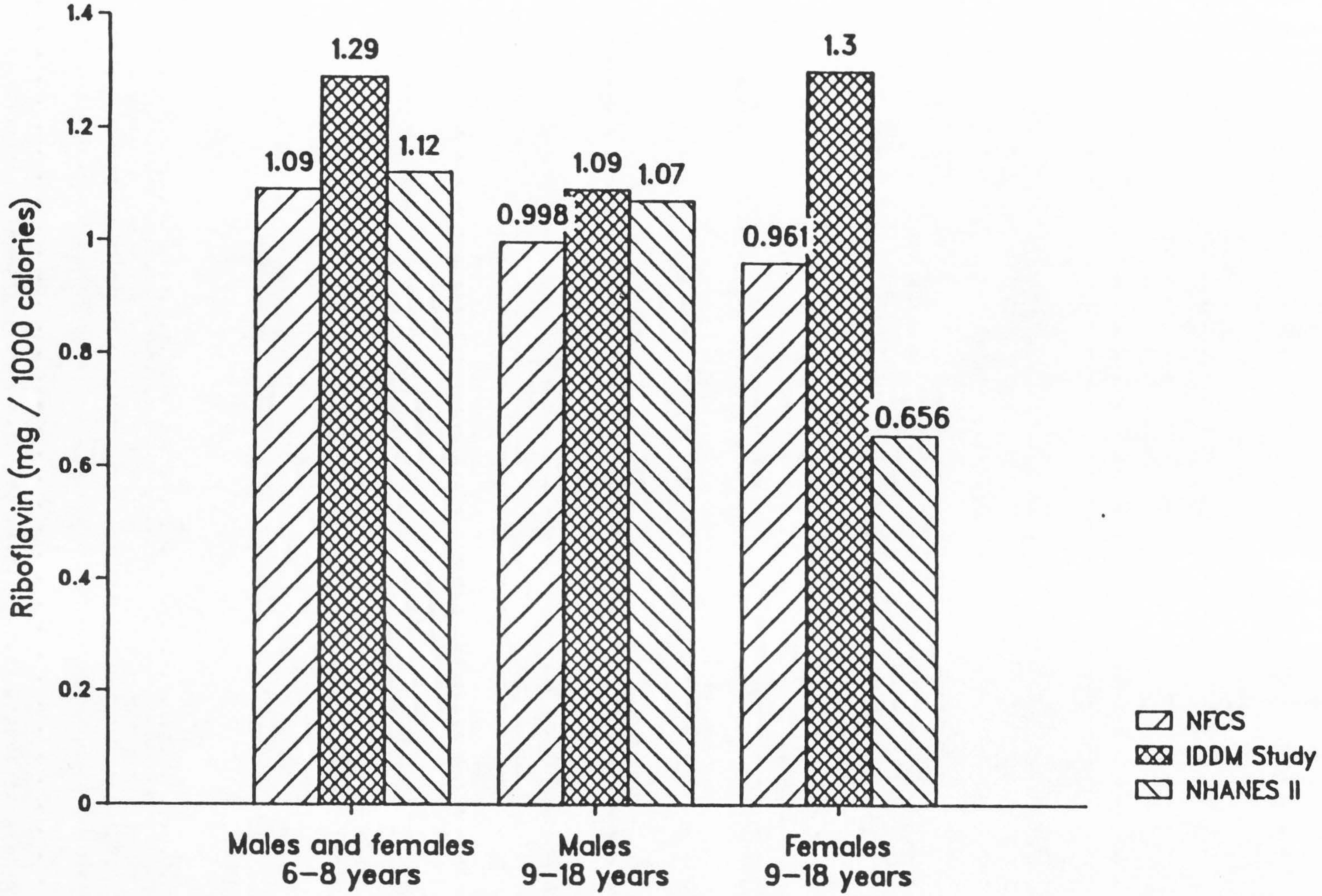

Figure 8. Mean intake of riboflavin per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

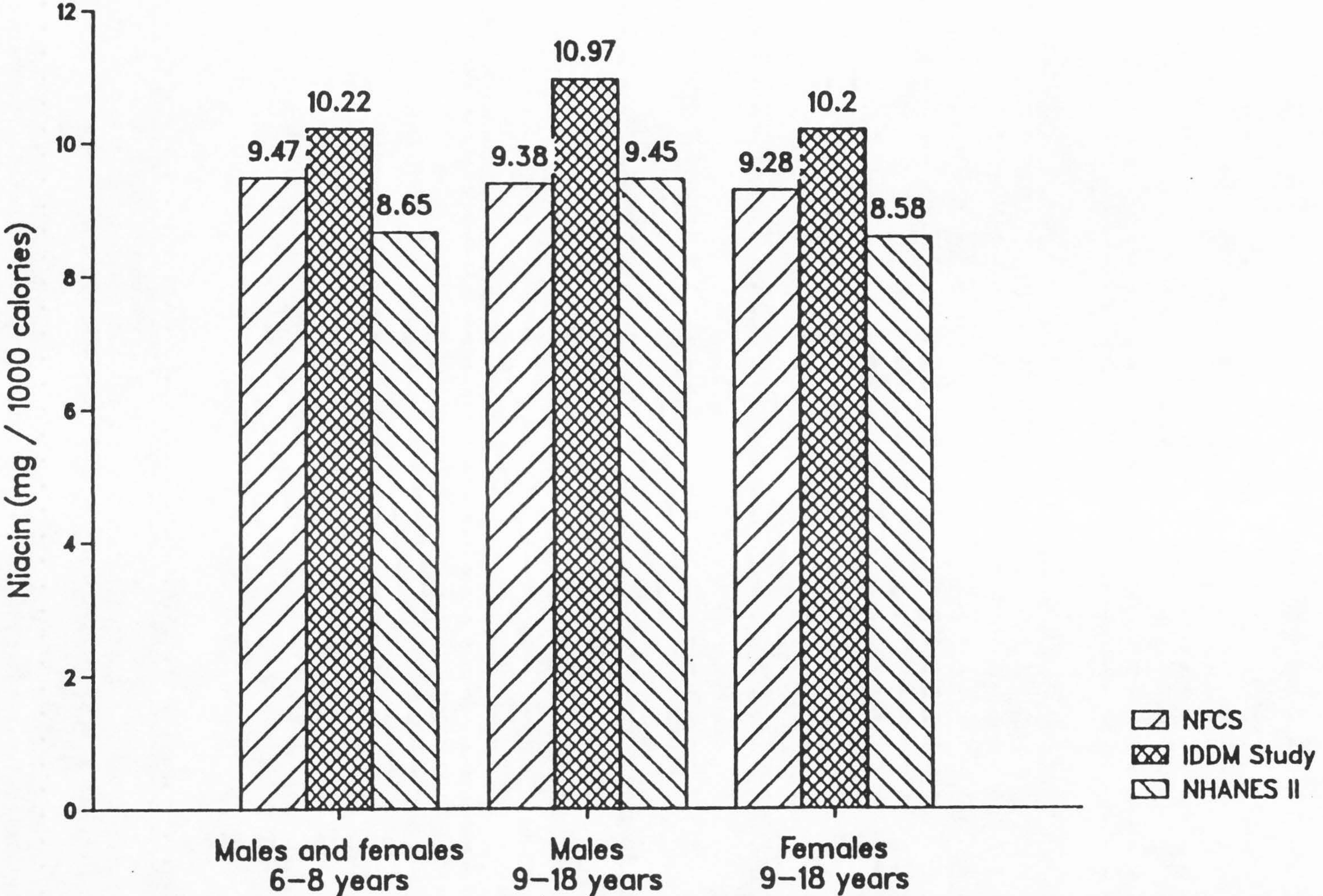

Figure 9. Mean intake of niacin per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

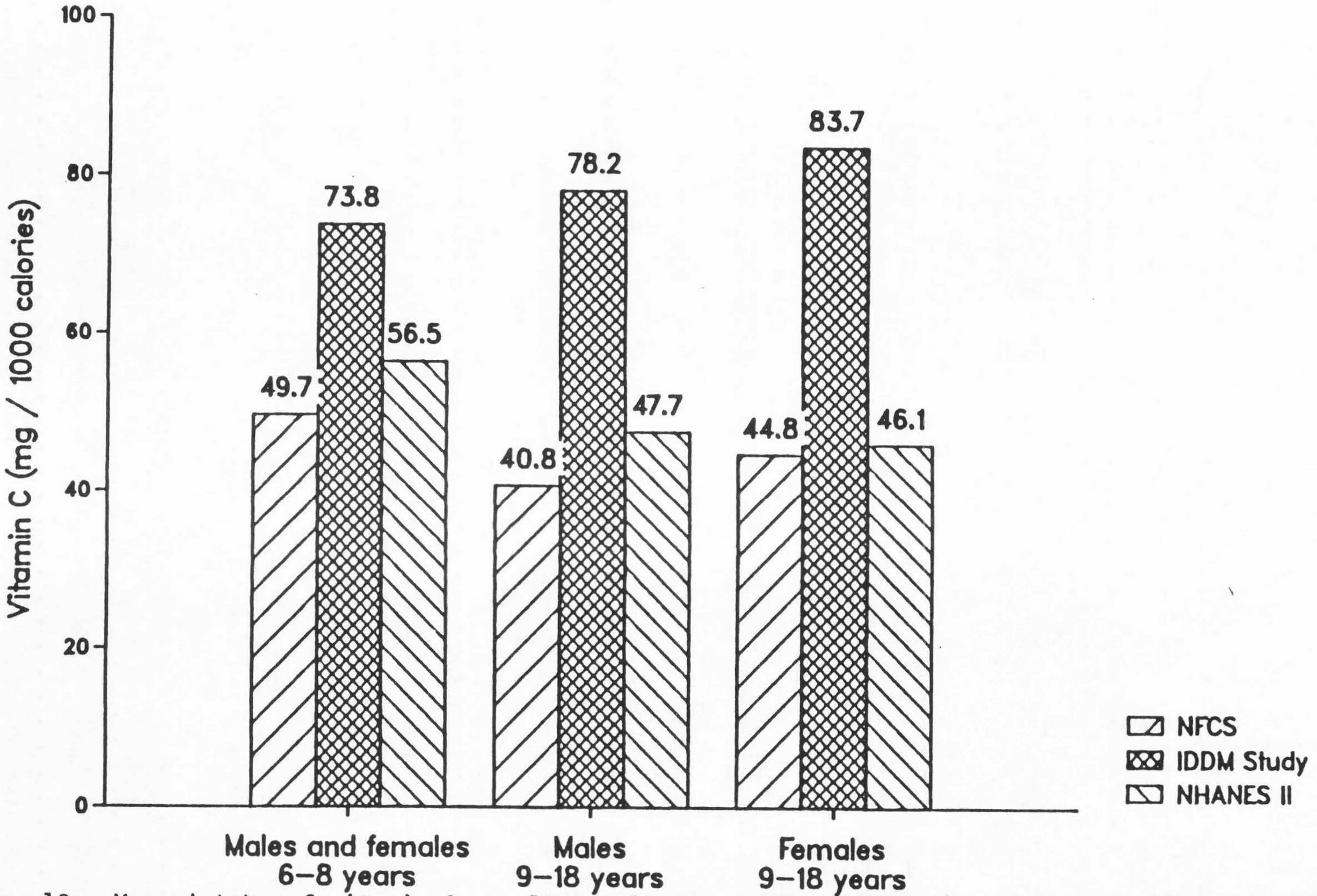

Figure 10. Mean intake of vitamin C per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

80 percent of the RDA. Nine and 15 of the total 22 subjects fell below 100 percent of the RDA for iron and zinc, respectively. Mean intakes are shown for age and sex subgroups in Tables 26 and 27. Below-standard intakes are shown in Table 22.

Since subjects' dietary guidance has emphasized inclusion of milk "choices" for most eating occasions, calcium and phosphorous needs were generally met. Comparison with calcium and phosorous intakes per 1,000 calories of the NFCS and NHANES II data demonstrates that the IDDM study group consumed substantially greater amounts of these nutrients (Figures 11 and 12). Magnesium intake of the study group appeared to be greater than that for comparble age groups from NFCS data (Table 28). No statistical analysis for difference between means were attempted due to the small sample size. Intakes of calcium were below 80 percent RDA for 12 to 14 year-old females and below 70 percent RDA for 15 to 18 year-old females for both national survey samples (Tables 23 and 24). Magnesium intakes of NFCS subjects were reported to be substantially below 80 percent RDA for 15 to 18 year-old females (Table 23). In comparison, mean calcium intakes of the study group did not fall below 90 percent RDA, and magnesium intakes did not fall below 80 percent of the RDA.

Seven to 10 year-old subjects consumed a mean of 144 percent of the standard for iron, while 11 to 15 year-old males consumed approximately 100 percent of the RDA. However, 11 to 16 year-old females' intakes fell substantially below 100 percent of the standard (ranging from 50 to 94 percent). It is generally accepted that the typical Western diet provides approximately five to six milligrams of

Table 26. Mean nutrient intake values for sex and age for 7-16 year-old subjects with IDDM based on 3-day dietary intake records.

Sex	Age (years)	n*	Vit. A (IU)	**S	Vit. C (mg)	S	Thi. (mg)	S	Ribo. (mg)	S	Nia. (mg)	S	B_6 (mg)	S	Fol (mcg)	S	B_{12} (mcg)	S	Ca (mg)	S	Phos (mg)	S	Magn (mg)	S	Fe (mg)	S	Zn (mg)	S
Males																												
	7-10	3	7250	2805	199	39.6	2.24	.40	3.42	.51	24.47	5.1	2.25	.33	409	86	7.53	.52	1953	322	2117	224	403	68.0	17.43	1.9	13.8	2.0
	11-14	6	7518	4503	109	53.6	2.05	.41	2.79	.64	31.53	11.7	2.20	.94	321	98.8	8.51	5.9	1528	409	2145	381	412	79.0	19.82	8.0	15.06	3.9
	15	1	4423		202		1.45		2.11		19.0		1.73		293		5.44		1432		1613		327		6.2		12.31	
Females																												
	7-10	6	7442	3341	132	42.8	1.89	.28	2.78	.70	21.75	2.8	2.17	.79	286	65.4	4.90	.87	1359	398	1603	305	338	43.0	14.2	1.6	10.0	1.6
	11-14	4	7195	3993	198	108	1.81	.52	2.58	.80	20.23	4.6	1.90	.51	352	51.3	5.48	1.7	1509	308	1790	361	309	79.4	15.2	5.9	11.79	2.7
	15-16	2	4160	441	159	28.3	1.66	.12	2.17	.28	18.65	1.34	1.72	.15	253	12.0	5.31	.06	1137	451	1457	267	260	29.0	13.7	.99	9.88	1.2

*n = number of subjects

**±Standard Deviation

Table 27. Mean nutrient intake values for 7-16 year-old subjects with IDDM based on 3-day dietary intake records.

Sex	Age (years)	*n	Calories	Pro (g)	Fat (g)	CHO (g)	Ca (mg)	Magn (mg)	Phos (mg)	Fe (mg)	Vit A (IU)	Thi (mg)	Ribo (mg)	Nia (mg)	B_6 (mg)	B_{12} (mcg)	Fe (mcg)	Vit C (mg)	CHOL (mg)
Males	7-8	2	2383	100	102	275	1772	366	1979	16.45	5648	2.02	3.10	21.55	2.11	7.23	395	203	609
	9-11	3	2774	115	126	305	1890	441	2061	17.60	6936	2.21	2.90	25.37	1.96	5.88	371	158	488
	12-14	4	2906	139	142	272	1504	406	2269	21.38	8688	2.08	3.02	35.85	2.42	10.67	330	93.25	569
	15	1	1688	78	58	214	1536	327	1661	4.6	5182	1.73	2.12	19.60	1.73	5.44	293	326	220
Females	7-8	2	1871	75	68	253	1111	329	1492	15.35	6332	1.76	2.40	21.9	1.92	5.51	222	111	299
	9-11	5	2214	90	96	260	1483	327	1685	13.34	7656	1.88	2.79	20.7	2.20	4.54	326	175	388
	12-14	3	2049	92	81	243	1517	322	1789	16.20	7495	1.91	2.75	21.37	1.94	5.86	348	164	315
	15-16	2	1691	75	67	203	1137	260	1457	13.70	4160	1.66	2.16	18.65	1.72	5.31	253	159	379

*n = number of subjects

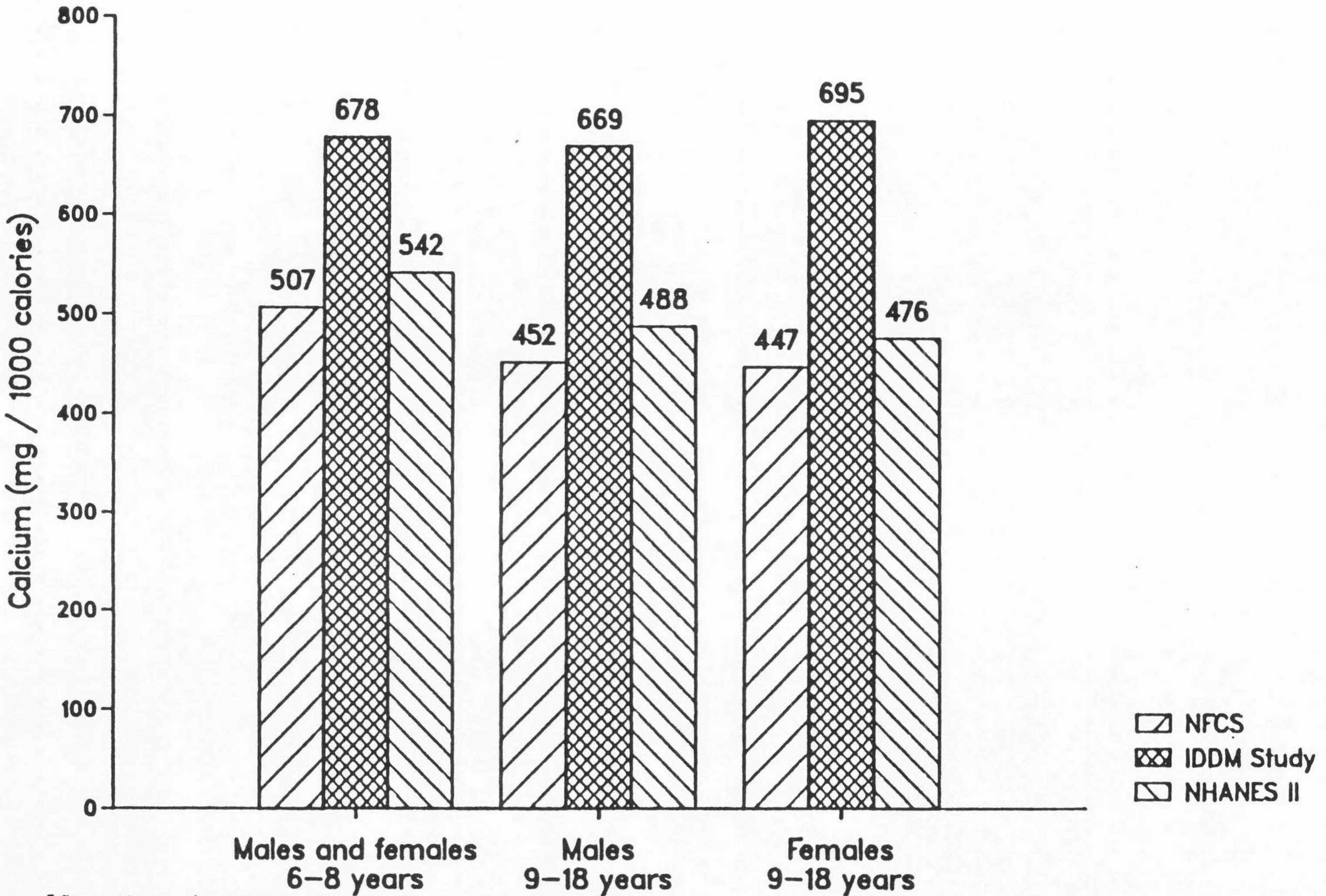

Figure 11. Mean intakes of calcium per 1000 calories. NFCS (1977-78), IDDM study group and NHANES II (1976-80).

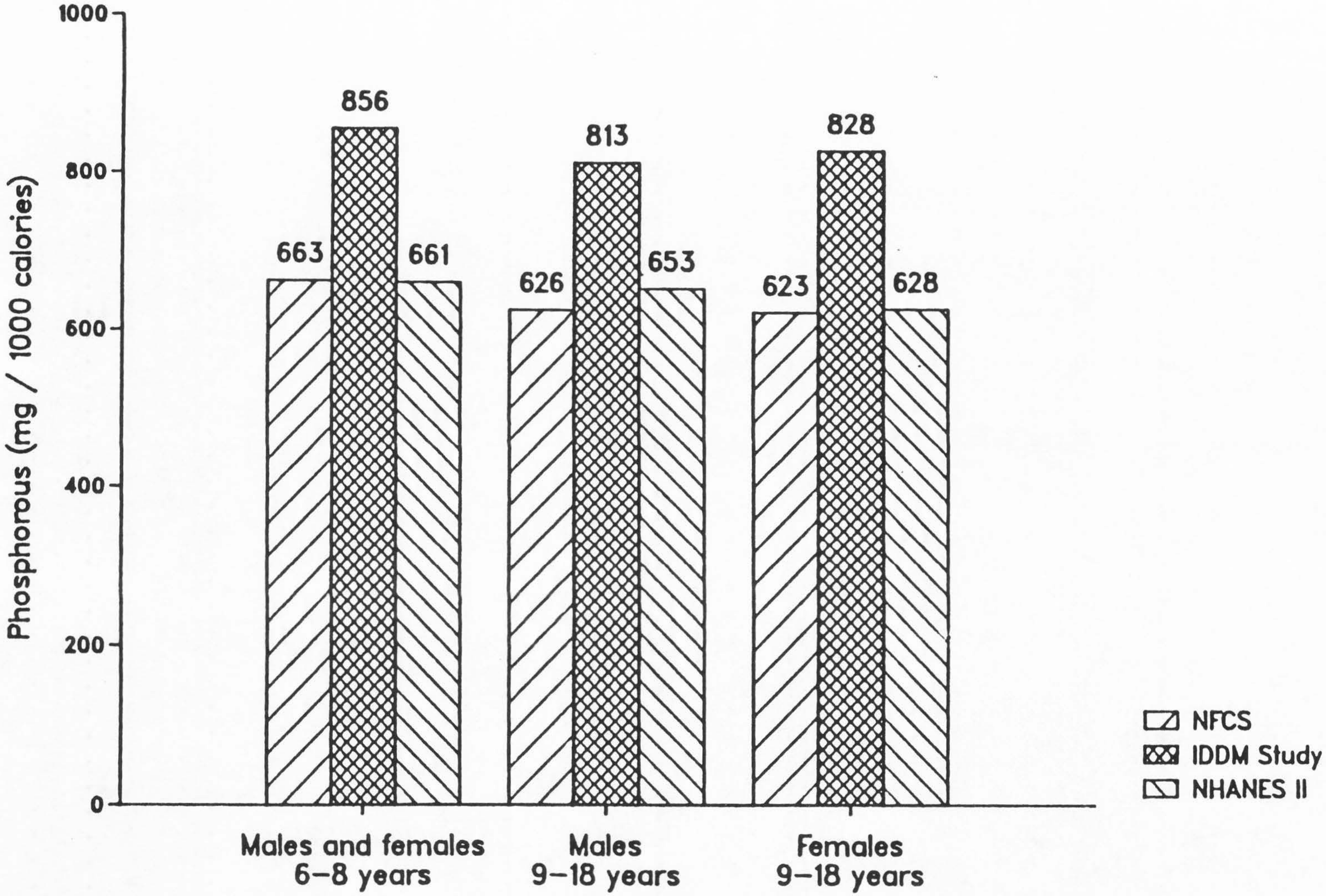

Figure 12. Mean intakes of phosphorous per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

Table 28. Magnesium intake of the IDDM study group and NFCS (1977-78) subjects: mean values in milligrams.

Sex	Age (years)	IDDM Study Population	NFCS 1977-78
Males and Females	6-8	348	*215
Males	9-11	441	245
	12-14	406	284
	15-18	*327	317
Females	9-11	327	237
	12-14	322	220
	15-18	260	215

*One subject only.

iron per 1000 kilocalories (Whitney and Hamilton, 1984). It is not unusual, then, that females of child-bearing age would receive less than the standard of 18 milligrams of iron. It would be wise to stress inclusion of iron-rich foods in the diet of the female subjects, including low-fat items such as fish, legumes, dark leafy greens, dried fruits and whole grain and enriched grain products. These foods are also excellent sources of magnesium, which was consumed in amounts below the RDA by some subjects in this study.

Iron intake of the one 15 year-old male subject, which was calculated to be 25.6 percent of the RDA (Table 22), was probably not an accurate estimate of iron intake. Carnation Instant Breakfast was consumed in substantial quantities by this subject, and no new iron values were available for the NUTREDFO data base for this product. This subject's apparently low iron intake deflated the 11 to 16 year age group mean, which is reflected in the bar graph portraying iron intake for this age group (Figure 13).

Though seven to ten year-olds' mean intake of zinc did not fall below 100 percent of RDA, 11 to 16 year-old females' mean intake was 74.7 percent of the standard. Table 22 depicts mean percentages below the RDA for zinc by age groups. An average 1500 kilocalorie diet provides approximately 6.3 milligrams of zinc per day (Holden et al., 1979). Therefore, since the RDA for this nutrient for all individuals above 10 years of age is 15 milligrams, it is probable that substandard amounts will be consumed unless greater than 3000 kcalories are ingested. This sample is probably not unlike the general non-diabetic population with regard to zinc consumption.

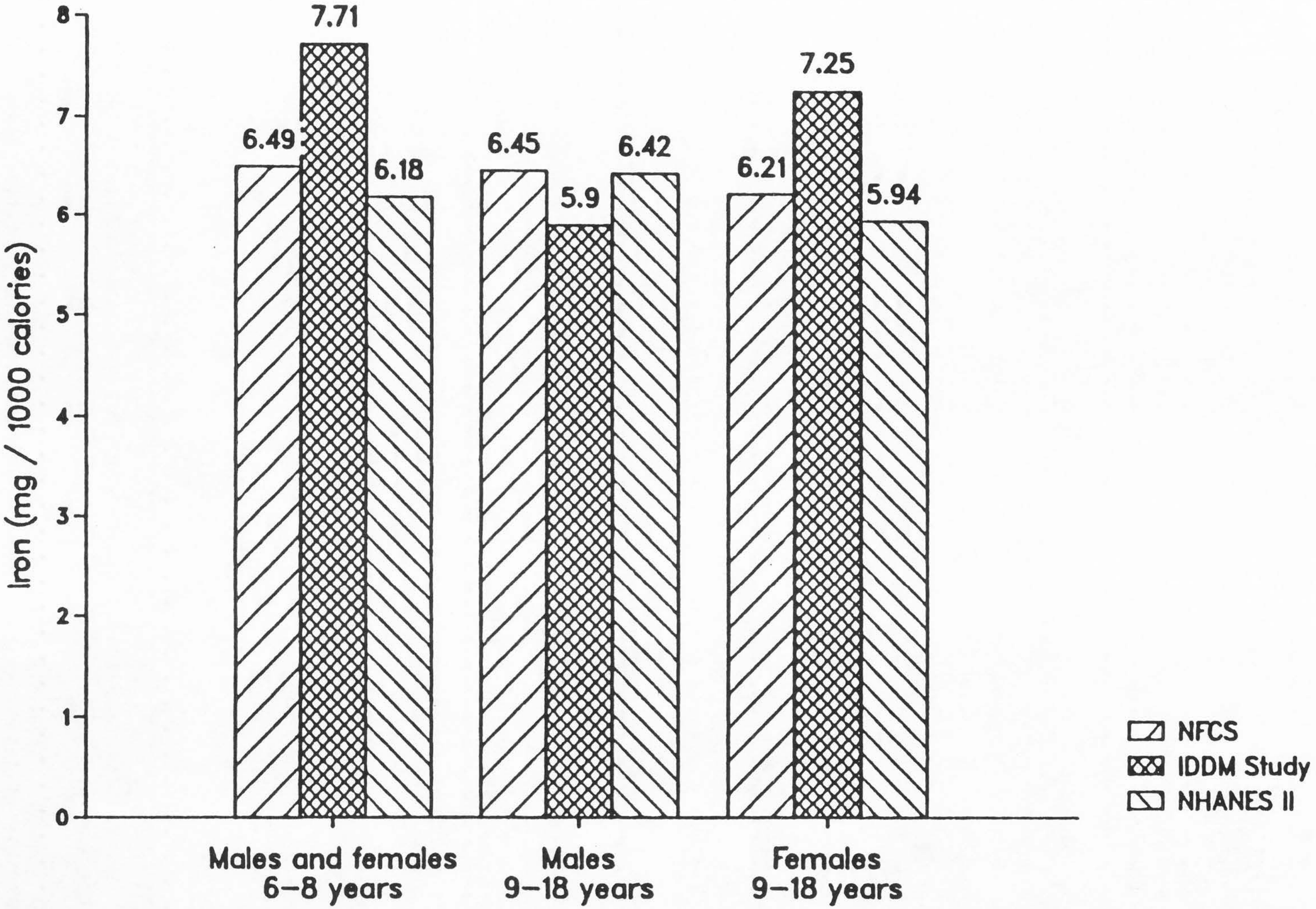

Figure 13. Mean intake of iron per 1000 calories: NFCS (1977-78), IDDM study group and NHANES II (1976-80).

Neither of the national surveys addressed zinc as part of the nutrient profiles examined.

Since zinc consumption was generally substandard for this group, food sources of this nutrient should be emphasized. Though high-protein foods such as meats, liver and shellfish are excellent sources of zinc, they also contribute substantial amounts of fat and cholesterol to the diet. Use of low-fat sources of animal protein should be emphasized, and concomitant use of skim milk could help to offset total fat intake. Since zinc functions so importantly in the growth process, and it has been suggested that youth with IDDM may be at risk for suboptimal growth patterns, it would be wise to ensure adequate amounts of this nutrient in the diet. Supplementation with no more than the RDA for this nutrient might also be considered.

Day-to-Day Variability of Intakes of Energy, Protein, Fat and Carbohydrate

Analysis of variance was utilized to examine day-to-day variability in nutrient intakes over the three-day time period observed. (The three days were not always consecutive days of the week). Results of the analysis are located in Appendices I through L. It was not surprising to find that males consumed greater amounts of total calories, protein and fat than females. No significant amount of day-to-day variability was found for any of the nutrients for both sexes separately and combined.

In another attempt to determine day-to-day variability of nutrient intakes, range was computed for each nutrient (Appendix M). Linear regression was then used to determine relationship between "variability" (as portrayed by range) and HbA_{1c} values. Since consistancy of day-to-day intake is stressed in diabetes education and is theorized to result in optimal levels of diabetes control, it was reasonable to ask whether large day-to-day variability would imply poor compliance with diabetes care regimens, which, in turn, might result in poorer levels of control. Results of the regression analysis (Appendix N) show that in general, range of dietary intake of each nutrient over the three days observed was a poor predictor of HbA_{1c}. Relationship of carbohydrate range and HbA_{1c}, however, was characterized by a correlation coefficient of .670 and a coefficient of determination of 0.449. Though these values would need to be higher to substantiate the existence of a meaningful relationship between range of carbohydrate intake and overall diabetes control, it is an interesting suggestion, since diabetes is a disorder of carbohydrate metabolism. A larger sample would be necessary to re-examine this prospect. This was a difficult concept to analyze statistically, as no acceptable level of variability has been established for use in treatment of IDDM.

Use of Special Dietetic Foods

The most commonly consumed "dietetic" foods were sugar substitutes, diet soda pop, dietetic maple syrup, jams and jellies and dietetic candies (chocolate and hard candy types). Use of dietetic gelatin and ice cream desserts and salad dressing was also reported. Frequency of use of these foods are shown in Table 29.

According to Jackson et al. (1978) dietetic soda and sweets are not desired components of the diet except for special occasions.

Table 29. Frequency of use of special dietetic foods by the IDDM study population.

Special Food	Number of Subjects
Sugar substitute	20 *
saccharin	17 * * * * * * * * * * * * * * * * *
aspartame	7 * * * * * * *
fructose	7 * * * * * * *
Diet pop	11 * * * * * * * * * * *
Dietetic maple syrup	12 * * * * * * * * * * * *
Dietetic jam or jelly	11 * * * * * * * * * * *
Dietetic candy	7 * * * * * * *
Dietetic gelatin desserts	3 * * *
Dietetic ice cream	1 *
Dietetic salad dressing	1 *

The American Diabetes Association (1979) has stated that the nutritional needs of diabetic persons should be met without the use of special dietetic foods. Dietetic foods usually contain calories and often, controversial ingredients such as the polyalcohols, saccharin or aspartame. The cost of these products, in addition, is usually higher than for nondietetic products. Such terms as "diet," "dietetic" and "diabetic" used on food labels have no consistent meaning regarding nutrient content of these products. Patients often tend to consume such products without regard to the energy content (Talbot and Fisher, 1978).

There are questions within the diabetes and nutrition literature as to whether or not, and to what extent, sucrose is to be allowed in the diabetic diet. Nuttall (1983) feels that, within reason, the diabetic patient should not be denied the pleasure of sweet-tasting foods. Crapo et al. (1976) and other researchers have demonstrated that the glycemic response to sucrose is substantially lower than that of glucose, and that combinations of foods result in varied glycemic responses. There is no concrete scientific data to prove that refined carbohydrates have no place in the diabetic diet (Nuttall and Gannon, 1981; Nuttall, 1983).

Often the clinician encounters the question as to what beverages are appropriate for between eating-occasion consumption by the diabetic patient. This issue has led professionals to search for non-calorically-sweetened beverages to take the place of calorie-containing beverages consumed freely by non-diabetic individuals (juices, milk and soft drinks). Since the diabetic patient is not always satisfied with plain iced tea or water, a safe, non-caloric sweetener would be a most appreciated discovery. Although certain sweeteners are currently available on the market (aspartame and saccharin) questions exist as to their safety. Gellis (1983, 1984) has proposed that until further research reveals answers to questions regarding the safety of aspartame, that it be avoided by the American public, especially the pediatric population.

Many professionals have condoned the use of dietetic beverages and non-caloric and caloric sweeteners in moderation. This seems to be a reasonable approach that might enable health care professionals to observe better compliance to self-care regimens by their diabetic clients. However, use of "dietetic" or "diabetic" foods, as well as the use of fructose and the polyalcohols should generally be discouraged as they provide no real benefit for the diabetic patient. Although the use of sorbitol, xylitol and fructose is well-accepted by the European diabetes community, adequate studies of long-term use of these substances have not been done, and the American diabetes community continues to discourage their use. Water-packed fruits and dietetic beverages are considered exceptions (Talbot and Fisher, 1978; Skyler, 1983).

Foods Used for Treatment of Hypoglycemia

Foods used by individuals in this study for treatment of insulin reactions included candy, fruit and juices, crackers, regular pop, frosting and glucose preparations manufactured specifically for this purpose (Glutose, Monogel and glucose tablets). The frequency of reported use of these foods and substances is portrayed in Table 30.

Although the use of such substances as frosting, candy and pop is generally not condoned for use with diabetic patients, the main objective at the time of an insulin reaction is to ingest sugar to increase blood sugar. Patients often will use the most convenient or closest food item. A problem that arises with use of candy-type items is that such foods are often a great temptation to individuals when not in the hypoglycemic state. For this reason, and for the fact that pure glucose can be rapidly absorbed, the special glucose products such as Monogel, Glutose and various glucose tablets were designed. The variety of forms (gel, liquid or tablet) allow the patient to choose the product most suitable to individual needs. Many young diabetics object to the use of these products, however, since they are immediately associated with the fact that they have diabetes. Many would rather friends saw them with "normal" foods (such as candy or pop) than with a strange-looking bottle of glucose solution. For this reason, foods containing natural sources of simple, carbohydrate (fruit, juices) might be suggested by diabetes educators, as use of those foods do not appear unusual in the presence of peers.

Six of the individuals in this study reported carrying no foods for insulin reactions. This should be discouraged, as the severe hypoglycemic state can have devastating consequences.

Table 30. Frequency of use of certain foods for treatment of hypoglycemia.

Food Item	Number of Subjects
Candy	8 * * * * * * * *
Juice	5 * * * * *
Fruit	4 * * * *
Monogel, Glutose or glucose tablets	3 * * *
Crackers	2 * *
Pop	1 *
Frosting	1 *

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Anthropometry

Height

Subjects appeared to be within normal percentile range for height as compared with the control population reported by the NCHS (1977), with the exception of two females who fell below the 10th percentile for age. Though metabolic control was not within optimal range for these subjects and duration of disease was substantial, parental height genetic factors and individual longitudinal growth data would need to be examined before growth delay could be substantiated. All males less than 12 years of age were below the 50th percentile range for height. However, the sample was not large enough to enable the researcher to substantiate growth disturbances, especially since no genetic information or longitudinal growth data had been observed.

Weight

The study group appeared to fall within a normal distribution for weight for age when compared to the HANES control population reported by the NCHS (1977). Weight:height percentile ratios were greater than 2.5:1 for two females (ages 11 and 15 years), indicating overweight for height. Three females and one male had weight:height percentile ratios substantially below 1:1, indicating low weight for height. It was possible that these individuals were experiencing linear growth spurts pending a corresponding gain in weight, or that poor metabolic control was resulting in loss of kilocalories via the urine. In addition, since activity levels were not taken into account when energy intakes were evaluated, more precise estimates of energy needs were not made.

SSF, TSF and MAMC

Subscapular skinfold measurements indicated that the study sample had adequate subcutaneous energy stores as compared to the norms derived from HES Cycles II and III data reported by the NCHS (1972; 1975). Only one subject fell below the 25th percentile for this parameter. No subjects fell below the 10th percentile. Triceps skinfold measurements also were consistent with adequate energy stores, and only one female subject fell below the 25th percentile for this parameter. Four females fell below the 10th percentile rank for MAMC, while no males' values were less than 15. Undernutrition was unlikely, as protein and energy intakes for these subjects were found to be generally adequate when compared to the RDA. Atrophy or hypertrophy at injection sites may also have affected these values. As a group the study sample fell into a distribution for this measurement within the normal range of the HES Cycle II and III norms reported by Frischancho (1981).

Glycosylated Hemoglobin

Glycosylated hemoglobin values averaged 11.7 percent for males and 12.3 percent for females. Although there is no widely accepted level that divides good and poor diabetes control, values above 11.5 percent are generally considered to be reflective of chronic hyperglycemia, although individual glycemic patterns vary and each subject must be assessed individually. The majority of subjects in this study had HbA_{1c} values reflective of only fair levels of control (five males and nine females in this group had HbA_{1c} values greater than 11.5 percent). No difference was found between means of males and females at α-.05 level of significance. Glycosylated hemoglobin had no significant effect on any of the studied growth parameters.

Age at Onset

Regression analysis revealed no significant relationship between age at onset of diabetes and HbA_{1c} levels or any of the anthropometric parameters.

Duration of Diabetes

Duration of diabetes had no significant effect on any of the studied growth parameters or on HbA_{1c} values, as shown using linear regression.

Dietary Intake Data

Energy intakes fell below the RDA (which was individually adjusted for weight and age) for four males and nine females. Males' intakes averaged 95.5 percent of the RDA while females' mean caloric intake was 86.1 percent of the RDA. These results were consistent with reports from the NFCS (1977-78) and NHANES II (1976-80) data for the same age groups. Since dietary intake information in these samples were based on either one-day recalls or three-day records, it is possible that energy intakes on the days evaluated did not reflect usual consumption patterns. Since longitudinal data on anthropometric measurements were not examined, no observations of body composition changes could be evaluated to substantiate inadequate kilocalorie intake in these subjects.

Protein intakes of all subjects in this study group were well above the RDA. Males' intakes averaged 260.8 percent and females' 210 percent of the RDA. These subjects' intakes tended toward the upper limits of the American Diabetes Association's 1979 recommendations for percentage of total energy supplied by protein. The majority of protein consumed came from animal sources. The IDDM study sample appeared to consume more protein per 1,000 kilocalories than either of the national survey samples.

P:S ratios indicated excessive consumption of saturated fat when compared to the recommended ratios of greater than 1.0. Cholesterol intakes tended to exceed current recommendations, especially in males. The IDDM study group appeared to have consumed more total cholesterol than the NHANES II data for the same age groups. No differences were found between males' and females' mean P:S ratios or mean cholesterol intakes per 1,000 kilocalories at α=.05 level of significance. Overall fat consumption tended to be above the American Diabetes Association's 1979 recommendations of no greater than 35 percent of total kilocalories. It was felt that the substantial intake of animal protein of this study sample contributed to the excessive fat consumption. These individuals might benefit from the use of skim milk, as fluid whole and low fat milk contributed substantial amounts of lipid to the diet.

The recommended proportion of total kilocalories to be supplied by carbohydrate was, on the average, not met. Nine of the subjects (41 percent) consumed less than 45 percent of total energy as carbohydrate. It was felt that the study group might benefit from an increase in carbohydrate intake to account for 50-60 percent of total kilocalories, as intake of protein, and thus, fat, would theoretically be displaced. Added sugar consumption did not exceed 7 percent of total kilocalories for any subjects in this study. The Dietary Goals for the U.S. include a recommendation for consumption of no more than 10 percent of total kilocalories from refined sugars. Mean intakes of the study sample fell well below this level. There are no recommendations from the diabetes community at this time regarding quantities of added sugar in the diets of diabetic individuals. Little scientific evidence exists, however, for the total exclusion of refined sugars in the diabetic diet.

Intakes of thiamin, riboflavin, niacin and vitamin B_{12} met or exceeded the RDA for all subjects. All but one individual met or exceeded the RDA for vitamin C and most individuals consumed adequate quantities of vitamin A. Intakes of vitamin B_6 tended to be below recommended levels and 50 percent of all subjects consumed amounts of folacin below the RDA. It must be kept in mind that methods for determining folacin and vitamin B_6 content of foods are not considered to be substantial at this point in time, and therefore interpretation of this data must be done with caution. The IDDM study group appeared to have higher mean intakes of vitamin A, thiamin, riboflavin and niacin than the two national survey samples, and higher mean intakes of vitamins B_6 and B_{12} than NFCS data revealed for the same age groups.

All subjects consumed phosphorous in amounts greater than or equal to the RDA. All but two individuals had intakes of calcium above 100 percent RDA for age and sex. It was felt that inclusion of milk and dairy products, which is emphasized as part of the Food and You (Prater et al., 1982) meal plan, could have contributed to the substantial amounts of calcium and phosphorous in the diets of these diabetic youths. Seven subjects' intakes fell below the RDA for magnesium, but none fell below 50 percent of the standard. Forty-one and 68 percent of all study individuals consumed less than the recommended amounts of iron and zinc, respectively. Since zinc and iron are found in relatively small amounts in the typical Western diet, it is difficult for individuals greater than 10 years of age (especially women) to consume the recommended amounts of these nutrients i.e. less than 3000 kcalories daily are usually consumed. Iron intake of one 15 year-old male subject had consumed substantial amounts of a product for which NUTREDFO had no recent iron values. It is possible that the iron intake of this subject was not as low as reported by NUTREDFO analysis. The study sample consumed mean amounts of calcium, phosphorous and, except for nine to 11 year-old males, iron that appeared to be greater than those reported by the two national survey samples for the same age groups. Magnesium intake of the study group, on the average, exceeded intakes for this nutrient reported in the NFCS data for corresponding age groups. It is possible that nutrient density of diets of these diabetic youth was actually higher than that of non-diabetic subjects reported by national survey data. If this is true, it is probably due to nutrition education and constant supervision of dietary intake of these diabetic youth by health professionals and parents.

There was no significant day-to-day variability demonstrated for intakes of total kilocalories, protein, fat and carbohydrate as determined by analysis of variance of three-day intakes of these nutrients. Linear regression revealed no significant relationship between range of intakes of these nutrients and HbA_{1c} levels.

Ranges of energy intake (calculated by subtracting the least number of kilocalories consumed from the most kilocalories consumed) of males were as low as 51 kilocalories and as high as 1808 kilocalories. Females' low and high range values were 31 kilocalories and 1125 kilocalories, respectively.

Subjects in this study reported use of a number of "diet," Dietetic" or "diabetic" foods. Ninety-one percent of all subjects reported using sucrose substitutes including saccharin, aspartame and fructose. Diet pop, and dietetic maple syrup, jam or jelly and candies were the other most frequently reported foods in this category. Use of most of these foods should be discouraged as they add extra expense and often provide no real benefit to the consumer with diabetes. Unsweetened canned fruit and diet pop are often thought to be exceptions, however, and may be useful to the diabetic individual. People with diabetes need to be educated with regard to components of these foods so that correct choices may be made about their use.

The subjective questionnaire used in this study also included requests for information about the types of foods carried/used for insulin reactions. Six subjects (27 percent) reported carrying nothing for the purpose of treating hypoglycemic episodes. Forty-one percent of the study group used fruit or juice, 36 percent used candy and 14 percent reported using glucose solutions, gels or tablets manufactured specifically for use in treating insulin reactions. Other foods used included crackers, pop and frosting. Education regarding preparation for potential hypoglycemic episodes is essential, as failure to respond to these episodes could be life-threatening.

Recommendations

Recommendations for further study include:

1. that the same subjects' growth parameters be followed in a longitudinal manner;
2. that these subjects' heights be evaluated controlling for parental height;
3. that lipid profiles of these subjects be examined to determine potential effect of current levels of fat in the diet;
4. that a larger sample of diabetic youth be evaluated for presence of growth disturbances (controlling for parental height) and for description of dietary intake patterns;

5. that dietary intake data of diabetic youth be assessed in terms of adequacy, and compared to age-matched group of non-diabetic controls using the same data base for nutrient analysis;
6. that intake of carbohydrate be increased (with the inclusion of whole grain foods and legumes) with a concomitant decrease in protein from animal sources as well as decreased saturated fat and cholesterol intake, and describing the effect of this leguminous high-carbohydrate diet on level of metabolic control in young diabetic individuals.

It is important and worthwhile to perform total assessment of the young individual with diabetes in the thorough manner demonstrated by this study. Growth should be monitored in a longitudinal manner and compared to familial growth patterns whenever possible. Routine dietary intake evaluation is valuable in assessing the nutrition component of care. Diabetes control (using home blood glucose monitoring as well as HbA_{1c}) needs to be assessed regularly, but as part of this thorough model for evaluation.

The treatment regimen for diabetes involves numerous components. The evaluation process should be just as thorough.

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APPENDICES

Appendix A

Letter of Explanation and Consent Form

Dear Parent:

A growth study on diabetic children ages 7-17 years is being conducted at Utah State University in Logan. We would appreciate your permission for your child to participate.

A number of factors are to be considered in this study:

A. Three-day dietary intake records are to be completed by the subject and/or the parents. This dietary information will be analyzed for nutritional adequacy using a computer program. Results will be available to you if you so request.

B. Growth measurements will be done on each subject, including height, weight, and some arm and back skinfold measurements. This information will help us to evaluate growth status of each particular child. National norms for these measurements will be used as standards.

C. Glycosylated hemoglobin values will be taken for each subject so that degree of metabolic control can be determined. A date appropriate for each family will be selected, on which the child is to come to Primary Children's Medical Center to have 1.5-3 ml blood drawn. The blood sampling procedure is consistent with Primary Children's Medical Center's laboratyory protocol for determination of glycosylated hemoglobin. There will be no charge to you for this laboratory procedure, and the results will be available to you and to your physician upon request.

The data will be kept confidential, and will not be associated with names.

Each family will be notified after winter camp to decide upon a date for the glycosylated hemoglobin determination. Growth measurements will be taken during camp. Information and forms for the diet histories will be issued at the time the measurements are taken.

Thank you!

Sincerely,

Shelly Clark, R.D.

I have received a copy of explanation of the procedures involved in this study. I hereby give permission for my child to participate. I understand that the child may withdraw from the study at any time. I am entitled to my child's results if I so request.

Date	Signature of parent or guardian if subject is under 18
Signature of Investigator	Signature of minor (10-18)
Signature of Principal Investigator	

Appendix B

Dietary Intake Record Information, Questionnaire and Reminder Letter

Instructions for Recording Dietary Intake

INSTRUCTIONS - List everything taken in "Food" column: examples below will assist you in describing the food, Record "amount" eaten in household measures (table- or teaspoons, cups) or by size or weight. Also note time and location in appropriate columns.

The following points should be remembered to make the diet record worth all of your efforts:

CEREALS

1. List brand name and type of cereal and amount eaten in cups (of fractions).
2. For cooked cereals, note if amount refers to dry cereal or cooked form; also specify amount of liquid used to prepare if different from package directions.
3. If milk, sugar, fruit, etc. added, note kind and amount that is actually eaten; i.e. if add 1/4 cup but leave 3 Tbsp., specify 1 Tbsp. as amount.

CHEESE AND YOGURT

1. Note kind of cheese. For sheese sold with different fat contents, specify type used (example: cottage cheese - reg. 4% or lowfat; mozzarella - whole or part skim).
2. For unsliced cheese, note dimensions (all 3), weight, or measure (cup, tbsp, etc.) of slice or portion eaten. For presliced, note weight/slice.
3. Yogurts: note brand, if made with lowfat or whole milk and if plain or fruit flavored.

FRUITS AND VEGETABLES

1. Specify fresh, frozen, canned (sweetened or unsweetened; juice pack or water pack) dried, etc. and how prepared.
2. If margarine, milk, cheese, or crumbs added, note kind and amounts.
3. SALADS: Specify amounts of ingredients eaten (example: lettuce, 1 cup, tomato, 1/4 med., carrot 1 tbsp. shredded) or proportions (example: 1 cup fruit salad - half apple, half grapes). IT IS NOT ENOUGH TO JUST LIST INGREDIENTS! SOME QUANTIFICATION IS NEEDED.

SOUPS

1. Canned soups: note if amount refers to diluted soup, and whether diluted with milk or water and whether is accordance with instructions on can.
2. Homemade soups: spedify all ingredients and amounts used in soup, and how much soup eaten. If soup is topped with extra ingredients be sure to include (i.e. croutons, cheese, etc.)

DESSERTS

1. List brand, or "homemade", or "bakery."
2. Candies or cookies: note kind and size.
3. Pies: note pan size and fraction eaten (1/5 of 9" pie) or size of wedge.
4. Cakes: Give dimensions of piece and specify icing, fillings, toppings, etc.)

BEVERAGES

Please measure in ounces the glass or cup usually used. Use this glass for beverages during the diet record period.

1. Milk: state if whole, 2%, skim, evaporated. List name and amounts of any flavoring or supplements, etc. added to milk.
2. Fruit Juices: List if fresh, frozen, canned or powdered; specify if sweetened or unsweetened. Give brand name, if possible.
3. Tea or Coffee: List amount of sugar, cream, lemon or artificial sweeteners/creamers added. If using an instant tea mix, please note if presweetened.

BREADS

1. Record kind - white, rye, whole wheat, etc. State if homemade or commercial (brand name, if possible), and if toasted. If piece was irregular shape, give dimensions (length, width and thickness) - this is especially important when loaf is bought unsliced, such as French bread.
2. If butter, margarine, jelly, mayonnaise, etc. added, note amount and kind.
3. Sandwiches: List all ingredients and amounts (example: bread, whole wheat, 2 slices; lettuce, 1 leaf, tomato, 1 slice; mayo. 1 tbsp.)

MEATS - POUNTRY - FISH

1. Give weight in ounces after cooking, or specify if weight is for uncooked portion. If weight in ounces in unknown, give dimensions (all 3) for the portion. See Portion Size Guide (Blue Sheet)
2. Specify the cut of meat (example: chicken drumstick, chuck, rib or sirloin steak, etc.) For gound beef, not if regular hamburger, lean or extra lean.
3. Specify how prepared - fried, baked, broiled, etc.

EGGS

1. Note size of egg used if other than large; note how prepared.
2. If milk, margarine, drippings, etc. used, note kind and amount.

FATS

1. Note if butter or margarine used. Give brand name and specify if tub (soft) or stick margarine, or if whipped, diet spread, etc.
2. Record amount eaten in teaspoons or tablespoons.
3. Include amounts used in cooking.

Example Food Intake Record

(EXAMPLE)

FOOD INTAKE RECORD

NAME ____________ HEIGHT ____________ WEIGHT ____________

DATES RECORDS WERE KEPT ____________ DAYS OF WEEK: M T W Th F Sat Sun

THESE DAY'S INTAKES WERE: Typical ____ More Than Usual ____ Less Than Usual ____

VIT/MIN SUPPLEMENTS USED? Yes ____ No ____ BRAND ____________

HOW OFTEN? Daily ____ Every Other Day ____ Weekly ____ Other ____________

TIME	WHERE EATEN	FOOD	DESCRIPTION	AMOUNT
7:00 AM	home	pancakes	4" diam. mix & milk & egg	2
		margarine	Parkay, soft	1 Tbsp.
		syrup		2 Tbsp.
		orange juice	frozen, reconstituted Minute Maid	4 oz.
		milk	2%	8 oz.
10:00 AM	school	apple	medium	1
12:30 PM	McDonald's	hamburger	regular	1
		french fries	small bag	1/2 bag
		milk	whole	8 oz.
4:00 PM	home	cottage cheese &	lowfat 1%	1/2 cup
		pineapple	canned, crushed, juice pack	2 T.
	home	fried steak	beef, round, 4" x 3" x 1/2"	1 piece
		mashed potato	instant w/milk, margarine	1/2 c
		salad: lettuce	iceberg, chunks	3/4 c
		tomato	medium	1/2
		dressing	1000 island	2 T.

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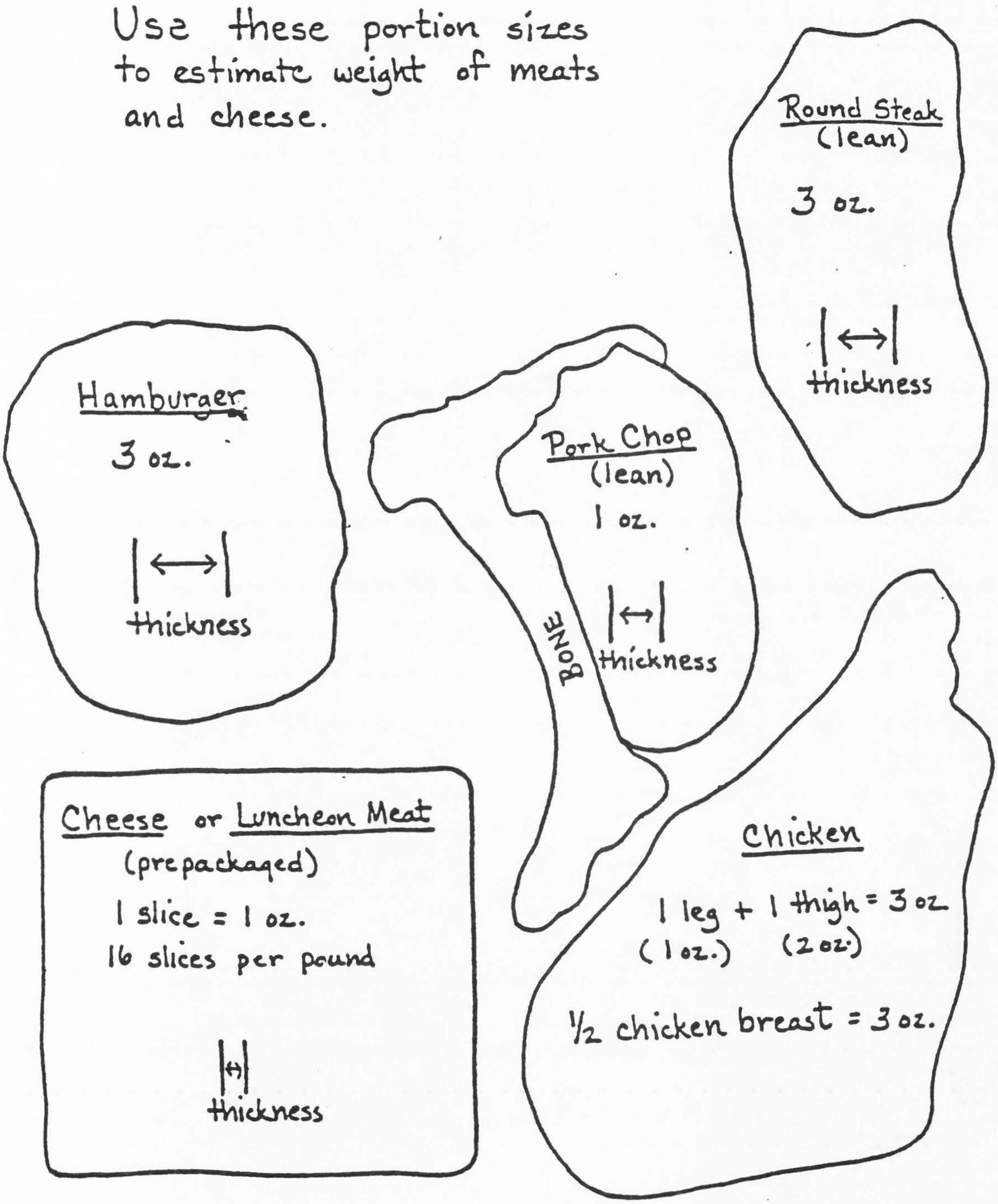
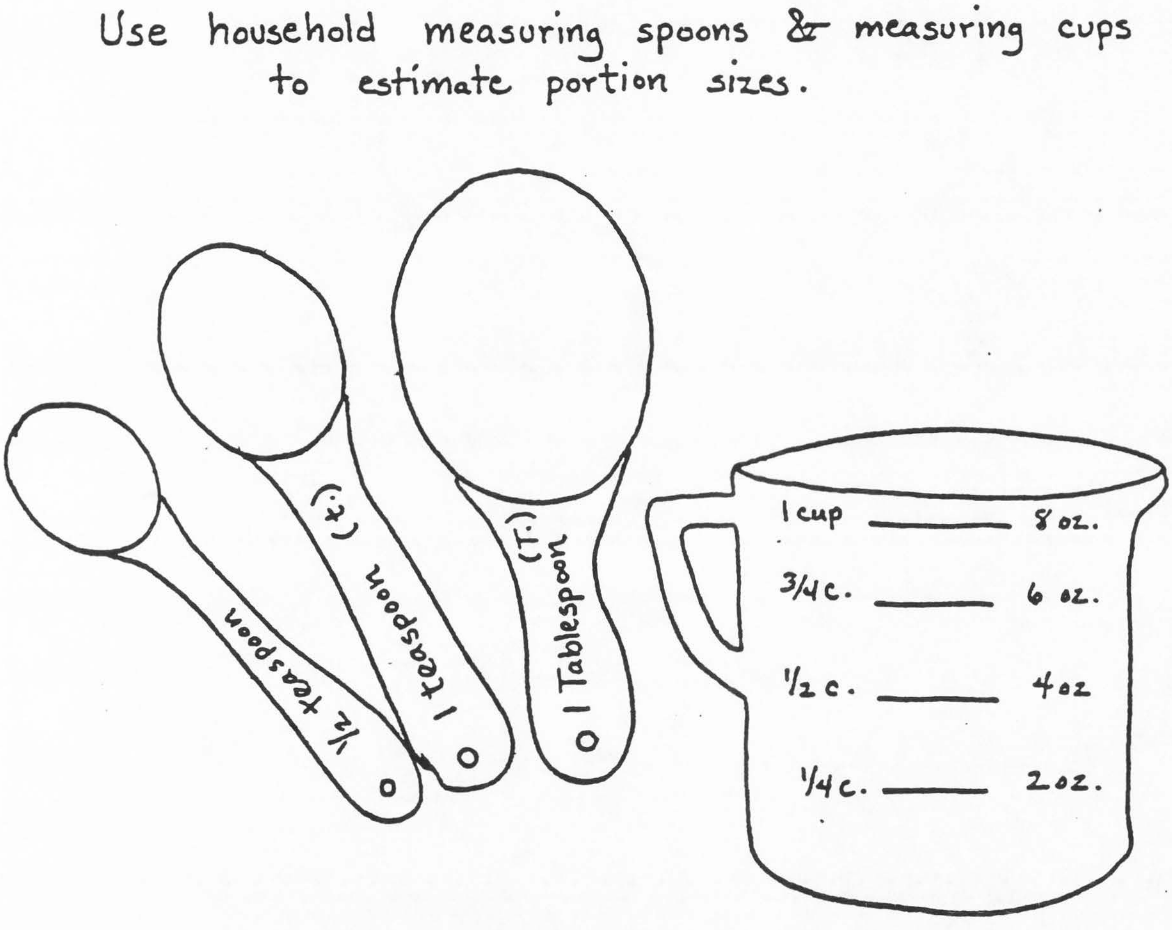
Examples of Portion Sizes (figures have been reduced).

PORTION SIZE GUIDE



Examples of Household Measures (figures have been reduced)



Food Intake Record Form

FOOD INTAKE RECORD

NAME ______________________ HEIGHT ______________ WEIGHT ______________

DATES RECORDS WERE KEPT ______________________ DAYS OF WEEK: M T W Th F Sat Sun

THESE DAY'S INTAKES WERE: Typical____ More Than Usual____ Less Than Usual____

VIT/MIN SUPPLEMENTS USED? Yes____ No____ BRAND ______________________

HOW OFTEN? Daily____ Every Other Day____ Weekly____ Other ______________

TIME	WHERE EATEN	FOOD	DESCRIPTION	AMOUNT

TAKE-HOME QUESTIONNAIRE

PLEASE ANSWER ALL QUESTIONS COMPLETELY

Name: ______________________________ 3. Telephone Number: __________

1. Address: _________________________ 4. Birthday: _________________

____
City State Zip County

2. Sex: ___Male ___Female 5. Married: ___Yes ___No 6. Student: ___Yes ___No

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOUR HEALTH-RELATED ACTIVITIES AND DIABETES.

7. Do you have diabetes mellitus? ___Yes ___No Year diagnosed ______

NUTRITION

8. What is the calorie level of your diet plan? ____________________
Don't know____

9. Does your diet plan include snacks between meals ___Yes ___No

10. What kind of food grouping system, if any, does your diet plan use?
____No grouping system ___ADA Exchange ___Food and You ___Other

11. What special dietetic foods, if any do you use?

None _____ Name Foods ____________________________________

12. Do you take supplements (vitamins, minerals)? ___Yes ___No
Name brand _________________

13. What sugar substitute(s), if any, do you use?
None ___________ Name substitute(s) ____________________________

14. What food, if any, do you carry for insulin reactions?
None _______ Name of Foods ___________________________________

Thank you very much for answering these questions. The information will be very helpful to health providers and educators in understanding your needs and daily challenges.

USU:BP/RAC
1984

March, 1983

Dear Participant,

Remember me? I'm Shelly, the dietitian who measured you in diabetes clinic at Primary.

I'm still working on my study and need to have your 3-day dietary intake record and the questionnaire back within the next month. I have your measurements but the study can't be completed without this additional information.

Enclosed are more forms, in case you need them.

The more people participating in my study, the more accurate my results!

I promise to send the results back to you when I finish.

Very sincerely,

Shelly Clark, R.D.

PLEASE HELP ME OUT!!!!

Appendix C

Anthropometry Standards

Smoothed Height Percentiles: NCHS (1977)

Table 13. Smoothed percentiles of stature (in centimeters), by sex and age: Data and statistics from National Center for Health Statistics, 2 to 18 years

Sex and age	Smoothed[1] percentile						
	5th	10th	25th	50th	75th	90th	95th
Male	Stature in centimeters						
2.0 years[2]	82.5	83.5	85.3	86.8	89.2	92.0	94.4
2.5 years	85.4	86.5	88.5	90.4	92.9	95.6	97.8
3.0 years	89.0	90.3	92.6	94.9	97.5	100.1	102.0
3.5 years	92.5	93.9	96.4	99.1	101.7	104.3	106.1
4.0 years	95.8	97.3	100.0	102.9	105.7	108.2	109.9
4.5 years	98.9	100.6	103.4	106.6	109.4	111.9	113.5
5.0 years	102.0	103.7	106.5	109.9	112.8	115.4	117.0
5.5 years	104.9	106.7	109.6	113.1	116.1	118.7	120.3
6.0 years	107.7	109.6	112.5	116.1	119.2	121.9	123.5
6.5 years	110.4	112.3	115.3	119.0	122.2	124.9	126.6
7.0 years	113.0	115.0	118.0	121.7	125.0	127.9	129.7
7.5 years	115.6	117.6	120.6	124.4	127.8	130.8	132.7
8.0 years	118.1	120.2	123.2	127.0	130.5	133.6	135.7
8.5 years	120.5	122.7	125.7	129.6	133.2	136.5	138.8
9.0 years	122.9	125.2	128.2	132.2	136.0	139.4	141.8
9.5 years	125.3	127.6	130.8	134.8	138.8	142.4	144.9
10.0 years	127.7	130.1	133.4	137.5	141.6	145.5	148.1
10.5 years	130.1	132.6	136.0	140.3	144.6	148.7	151.5
11.0 years	132.6	135.1	138.7	143.3	147.8	152.1	154.9
11.5 years	135.0	137.7	141.5	146.4	151.1	155.6	158.5
12.0 years	137.6	140.3	144.4	149.7	154.6	159.4	162.3
12.5 years	140.2	143.0	147.4	153.0	158.2	163.2	166.1
13.0 years	142.9	145.8	150.5	156.5	161.8	167.0	169.8
13.5 years	145.7	148.7	153.6	159.9	165.3	170.5	173.4
14.0 years	148.8	151.8	156.9	163.1	168.5	173.8	176.7
14.5 years	152.0	155.0	160.1	166.2	171.5	176.6	179.5
15.0 years	155.2	158.2	163.3	169.0	174.1	178.9	181.9
15.5 years	158.3	161.2	166.2	171.5	176.3	180.8	183.9
16.0 years	161.1	163.9	168.7	173.5	178.1	182.4	185.4
16.5 years	163.4	166.1	170.6	175.2	179.5	183.6	186.6
17.0 years	164.9	167.7	171.9	176.2	180.5	184.4	187.3
17.5 years	165.6	16[illegible].5	172.4	176.7	181.0	185.0	187.6
18.0 years	165.7	168.7	172.3	176.8	181.2	185.3	187.6

Smoothed Height Percentiles: NCHS (1977)
(continued)

Female							
2.0 years[2]	81.6	82.1	84.0	86.8	89.3	92.0	93.6
2.5 years	84.6	85.3	87.3	90.0	92.5	95.0	96.6
3.0 years	88.3	89.3	91.4	94.1	96.6	99.0	100.6
3.5 years	91.7	93.0	95.2	97.9	100.5	102.8	104.5
4.0 years	95.0	96.4	98.8	101.6	104.3	106.6	108.3
4.5 years	98.1	99.7	102.2	105.0	107.9	110.2	112.0
5.0 years	101.1	102.7	105.4	108.4	111.4	113.8	115.6
5.5 years	103.9	105.6	108.4	111.6	114.8	117.4	119.2
6.0 years	106.6	108.4	111.3	114.6	118.1	120.8	122.7
6.5 years	109.2	111.0	114.1	117.6	121.3	124.2	126.1
7.0 years	111.8	113.6	116.8	120.6	124.4	127.6	129.5
7.5 years	114.4	116.2	119.5	123.5	127.5	130.9	132.9
8.0 years	116.9	118.7	122.2	126.4	130.6	134.2	136.2
8.5 years	119.5	121.3	124.9	129.3	133.6	137.4	139.6
9.0 years	122.1	123.9	127.7	132.2	136.7	140.7	142.9
9.5 years	124.8	126.6	130.6	135.2	139.8	143.9	146.2
10.0 years	127.5	129.5	133.6	138.3	142.9	147.2	149.5
10.5 years	130.4	132.5	136.7	141.5	146.1	150.4	152.8
11.0 years	133.5	135.6	140.0	144.8	149.3	153.7	156.2
11.5 years	136.6	139.0	143.5	148.2	152.6	156.9	159.5
12.0 years	139.8	142.3	147.0	151.5	155.8	160.0	162.7
12.5 years	142.7	145.4	150.1	154.6	158.8	162.9	165.6
13.0 years	145.2	148.0	152.8	157.1	161.3	165.3	168.1
13.5 years	147.2	150.0	154.7	159.0	163.2	167.3	170.0
14.0 years	148.7	151.5	155.9	160.4	164.6	168.7	171.3
14.5 years	149.7	152.5	156.8	161.2	165.6	169.8	172.2
15.0 years	150.5	153.2	157.2	161.8	166.3	170.5	172.8
15.5 years	151.1	153.6	157.5	162.1	166.7	170.9	173.1
16.0 years	151.6	154.1	157.8	162.4	166.9	171.1	173.3
16.5 years	152.2	154.6	158.2	162.7	167.1	171.2	173.4
17.0 years	152.7	155.1	158.7	163.1	167.3	171.2	173.5
17.5 years	153.2	155.6	159.1	163.4	167.5	171.1	173.5
18.0 years	153.6	156.0	159.6	163.7	167.6	171.0	173.6

[1]Smoothed by cubic-spline approximation, as described in appendix II.

[2]Because of a logistic problem the percentiles of stature for children under 2.5 years are not highly reliable. The age interval represented is 2.00-2.25 years.

Smoothed Weight Percentiles: NCHS (1977)

Table 14. Smoothed percentiles of weight (in kilograms), by sex and age: Data and statistics from National Center for Health Statistics, 1.5 to 18 years

Sex and age	Smoothed[1] percentile						
	5th	10th	25th	50th	75th	90th	95th
Male	Weight in kilograms						
1.5 years	9.72	10.18	10.81	11.09	12.02	12.95	14.42
2.0 years	10.49	10.96	11.55	12.34	13.36	14.38	15.50
2.5 years	11.27	11.77	12.55	13.52	14.81	15.71	16.61
3.0 years	12.06	12.58	13.52	14.62	15.78	16.95	17.77
3.5 years	12.84	13.41	14.46	15.58	16.90	18.16	18.98
4.0 years	13.64	14.24	15.39	16.69	17.99	19.32	20.27
4.5 years	14.45	15.10	16.30	17.69	19.06	20.50	21.63
5.0 years	15.27	15.96	17.22	18.67	20.14	21.70	23.09
5.5 years	16.09	16.83	18.14	19.67	21.25	22.96	24.66
6.0 years	16.93	17.72	19.07	20.69	22.40	24.31	26.34
6.5 years	17.78	18.62	20.02	21.74	23.62	25.76	28.16
7.0 years	18.64	19.53	21.00	22.85	24.94	27.36	30.12
7.5 years	19.52	20.45	22.02	24.03	26.38	29.11	32.73
8.0 years	20.40	21.39	23.09	25.30	27.91	31.06	34.51
8.5 years	21.31	22.34	24.21	26.66	29.61	33.27	36.96
9.0 years	22.25	23.33	25.40	28.13	31.46	35.57	39.58
9.5 years	23.25	24.38	26.68	29.73	33.46	38.11	42.35
10.0 years	24.33	25.52	28.07	31.44	35.61	40.80	45.27
10.5 years	25.51	26.78	29.59	33.30	37.92	43.63	48.31
11.0 years	26.80	28.17	31.25	35.30	40.38	46.57	51.47
11.5 years	28.24	29.72	33.08	37.46	43.00	49.61	54.73
12.0 years	29.85	31.46	35.09	39.78	45.77	52.73	58.09
12.5 years	31.64	33.41	37.31	42.27	48.70	55.91	61.52
13.0 years	33.64	35.60	39.74	44.95	51.79	59.12	65.02
13.5 years	35.85	38.03	42.40	47.81	55.02	62.35	68.51
14.0 years	38.22	40.64	45.21	50.77	58.31	65.57	72.13
14.5 years	40.66	43.34	48.08	53.76	61.58	68.76	75.66
15.0 years	43.11	46.06	50.92	56.71	64.72	71.91	79.12
15.5 years	45.50	48.69	53.64	59.51	67.64	74.98	82.45
16.0 years	47.74	51.16	56.16	62.10	70.26	77.97	85.62
16.5 years	49.76	53.39	58.38	64.39	72.46	80.84	88.59
17.0 years	51.50	55.28	60.22	66.31	74.17	83.58	91.31
17.5 years	52.89	56.78	61.61	67.78	75.32	86.14	93.73
18.0 years	53.97	57.89	62.61	68.88	76.04	88.41	95.76

Smoothed Weight Percentiles: NCHS (1977)
(continued)

Female

1.5 years	9.02	9.16	9.81	10.38	10.94	11.76	12.36
2.0 years	9.95	10.32	10.96	11.80	12.73	13.58	14.15
2.5 years	10.80	11.35	12.11	13.03	14.23	15.16	15.76
3.0 years	11.61	12.26	13.11	14.10	15.50	16.54	17.22
3.5 years	12.37	13.08	14.00	15.07	16.59	17.77	18.58
4.0 years	13.11	13.84	14.80	15.96	17.58	18.93	19.91
4.5 years	13.83	14.56	15.55	16.81	18.48	20.06	21.24
5.0 years	14.55	15.26	16.29	17.66	19.39	21.23	22.62
5.5 years	15.29	15.97	17.05	18.56	20.36	22.48	24.11
6.0 years	16.05	16.72	17.86	19.52	21.44	23.89	25.76
6.5 years	16.85	17.51	18.76	20.61	22.68	25.50	27.59
7.0 years	17.71	18.39	19.78	21.84	24.16	27.39	29.68
7.5 years	18.62	19.37	20.95	23.26	25.90	29.57	32.07
8.0 years	19.62	20.45	22.26	24.84	27.88	32.04	34.71
8.5 years	20.68	21.64	23.70	26.58	30.08	34.73	37.58
9.0 years	21.82	22.92	25.27	28.46	32.44	37.60	40.64
9.5 years	23.05	24.29	26.94	30.45	34.94	40.61	43.85
10.0 years	24.36	25.76	28.71	32.55	37.53	43.70	47.17
10.5 years	25.75	27.32	30.57	34.72	40.17	46.84	50.57
11.0 years	27.24	28.97	32.49	36.95	42.84	49.96	54.00
11.5 years	28.83	30.71	34.48	39.23	45.48	53.03	57.42
12.0 years	30.52	32.53	36.52	41.53	48.07	55.99	60.81
12.5 years	32.30	34.42	38.59	43.84	50.56	58.81	64.12
13.0 years	34.14	36.35	40.65	46.10	52.91	61.45	67.30
13.5 years	35.98	38.26	42.66	48.26	55.11	63.87	70.30
14.0 years	37.78	40.11	44.64	50.28	57.09	66.04	73.08
14.5 years	39.45	41.83	46.28	52.10	58.84	67.95	75.60
15.0 years	40.99	43.38	47.82	53.68	60.32	69.54	77.78
15.5 years	42.32	44.72	49.10	54.96	61.48	70.79	79.59
16.0 years	43.41	45.78	50.09	55.89	62.29	71.68	80.99
16.5 years	44.20	46.54	50.76	56.44	62.76	72.18	81.93
17.0 years	44.74	47.04	51.14	56.69	62.91	72.38	82.46
17.5 years	45.08	47.33	51.33	56.71	62.89	72.37	82.62
18.0 years	45.26	47.47	51.39	56.62	62.78	72.26	82.47

[1]Smoothed by cubic spline approximation, as described in appendix II.

Subscapular Skinfold Percentile Values of Children 6-11 Years of Age: NCHS (1972)

WEST												
Boys 6-11 years----	928	3,107	5.6	3.17	0.29	3.0	4.0	4.0	4.5	6.0	8.0	11.0
6 years-----------------	145	522	4.9	2.55	0.29	3.0	3.0	4.0	4.0	5.0	7.0	8.0
7 years-----------------	168	562	4.8	2.49	0.21	3.0	4.0	4.0	4.0	5.0	6.0	7.5
8 years-----------------	161	548	5.2	2.73	0.34	3.0	4.0	4.0	4.5	6.0	6.5	8.5
9 years-----------------	146	477	5.8	3.32	0.39	3.0	3.5	4.0	5.0	6.0	9.0	12.0
10 years----------------	142	483	6.0	3.20	0.29	3.0	4.0	4.0	5.0	7.0	9.0	10.5
11 years----------------	166	516	6.8	4.01	0.46	4.0	4.0	4.5	6.0	8.0	13.0	18.0
Girls 6-11 years---	806	2,806	6.3	3.38	0.28	3.5	4.0	4.0	5.0	7.0	10.0	12.5
6 years-----------------	137	560	4.8	1.51	0.22	3.0	3.5	4.0	4.0	5.5	7.0	7.0
7 years-----------------	121	402	5.1	1.70	0.17	3.5	4.0	4.0	4.0	6.0	7.5	8.0
8 years-----------------	148	494	6.4	3.01	0.35	3.5	4.0	4.0	6.0	8.0	10.5	12.5
9 years-----------------	131	440	7.0	4.22	0.57	4.0	4.0	5.0	6.0	7.0	12.0	16.0
10 years----------------	146	505	6.9	3.46	0.55	4.0	4.0	4.5	6.0	8.0	10.0	14.0
11 years----------------	123	405	7.8	4.50	0.42	4.0	4.0	5.0	6.0	9.0	14.0	18.0

NOTE: n = sample size; N = estimated number of children in population in thousands; $\bar{X}$ = mean; s = standard deviation; $s_{\bar{x}}$ = standard error of the mean.

Subscapular Skinfold Percentile Values of Youth 12-17 Years of Age: NCHS (1974)

WEST												
Male												
12 years	154	543	7.0	5.45	0.79	3.5	4.0	4.5	5.5	7.3	11.6	17.7
13 years	152	490	8.0	5.87	0.57	3.9	4.2	4.8	5.9	8.8	16.1	21.8
14 years	150	489	8.5	6.46	0.67	3.9	4.4	5.3	6.3	9.2	14.7	25.5
15 years	151	475	8.2	4.62	0.46	4.8	5.3	6.2	7.2	8.8	12.6	18.0
16 years	131	453	8.0	4.47	0.37	4.6	5.1	6.0	7.2	8.7	13.0	17.0
17 years	125	496	9.3	4.67	0.66	5.3	5.8	6.6	7.6	10.5	17.4	20.5
Female												
12 years	134	485	8.1	4.42	0.51	4.3	4.8	5.7	6.9	9.1	14.2	17.7
13 years	138	493	9.9	6.28	0.63	4.7	5.2	6.2	7.9	10.9	19.2	23.2
14 years	138	478	10.8	5.64	0.50	5.3	6.1	7.2	9.3	13.5	17.6	20.9
15 years	135	493	11.5	6.03	0.68	5.4	6.2	7.7	10.2	14.4	20.1	24.7
16 years	145	513	12.7	6.98	0.78	6.2	6.8	7.8	10.9	14.9	24.6	29.2
17 years	113	410	13.5	8.25	1.38	6.4	7.0	7.9	11.1	17.5	23.6	35.1

NOTE: n = sample size; N = estimated number of youths in population in thousands; $\bar{X}$ = mean; s = standard deviation; $s_{\bar{x}}$ = standard error of the mean.

Triceps Skinfold Percentile Values: Frisancho (1981)

Percentiles for triceps skinfold for whites of the United States Health and Nutrition Examination Survey I of 1971 to 1974

Age group	Triceps skinfold percentiles (mm^2)															
	n	5	10	25	50	75	90	95	n	5	10	25	50	75	90	95
	Males								Females							
1–1.9	228	6	7	8	10	12	14	16	204	6	7	8	10	12	14	16
2–2.9	223	6	7	8	10	12	14	15	208	6	8	9	10	12	15	16
3–3.9	220	6	7	8	10	11	14	15	208	7	8	9	11	12	14	15
4–4.9	230	6	6	8	9	11	12	14	208	7	8	8	10	12	14	16
5–5.9	214	6	6	8	9	11	14	15	219	6	7	8	10	12	15	18
6–6.9	117	5	6	7	8	10	13	16	118	6	6	8	10	12	14	16
7–7.9	122	5	6	7	9	12	15	17	126	6	7	9	11	13	16	18
8–8.9	117	5	6	7	8	10	13	16	118	6	8	9	12	15	18	24
9–9.9	121	6	6	7	10	13	17	18	125	8	8	10	13	16	20	22
10–10.9	146	6	6	8	10	14	18	21	152	7	8	10	12	17	23	27
11–11.9	122	6	6	8	11	16	20	24	117	7	8	10	13	18	24	28
12–12.9	153	6	6	8	11	14	22	28	129	8	9	11	14	18	23	27
13–13.9	134	5	5	7	10	14	22	26	151	8	8	12	15	21	26	30
14–14.9	131	4	5	7	9	14	21	24	141	9	10	13	16	21	26	28
15–15.9	128	4	5	6	8	11	18	24	117	8	10	12	17	21	25	32
16–16.9	131	4	5	6	8	12	16	22	142	10	12	15	18	22	26	31
17–17.9	133	5	5	6	8	12	16	19	114	10	12	13	19	24	30	37
18–18.9	91	4	5	6	9	13	20	24	109	10	12	15	18	22	26	30
19–24.9	531	4	5	7	10	15	20	22	1060	10	11	14	18	24	30	34
25–34.9	971	5	6	8	12	16	20	24	1987	10	12	16	21	27	34	37
35–44.9	806	5	6	8	12	16	20	23	1614	12	14	18	23	29	35	38
45–54.9	898	6	6	8	12	15	20	25	1047	12	16	20	25	30	36	40
55–64.9	734	5	6	8	11	14	19	22	809	12	16	20	25	31	36	38
65–74.9	1503	4	6	8	11	15	19	22	1670	12	14	18	24	29	34	36

MAMC Percentile Values: Frisancho (1981)

Percentiles of upper arm circumference (mm) and estimated upper arm muscle circumference (mm) for whites of the United States Health and Nutrition Examination Survey I of 1971 to 1974

Age group	Arm circumference (mm)							Arm muscle circumference (mm)						
	5	10	25	50	75	90	95	5	10	25	50	75	90	95
Males														
1–1.9	142	146	150	159	170	176	183	110	113	119	127	135	144	147
2–2.9	141	145	153	162	170	178	185	111	114	122	130	140	146	150
3–3.9	150	153	160	167	175	184	190	117	123	131	137	143	148	153
4–4.9	149	154	162	171	180	186	192	123	126	133	141	148	156	159
5–5.9	153	160	167	175	185	195	204	128	133	140	147	154	162	169
6–6.9	155	159	167	179	188	209	228	131	135	142	151	161	170	177
7–7.9	162	167	177	187	201	223	230	137	139	151	160	168	177	190
8–8.9	162	170	177	190	202	220	245	140	145	154	162	170	182	187
9–9.9	175	178	187	200	217	249	257	151	154	161	170	183	196	202
10–10.9	181	184	196	210	231	262	274	156	160	166	180	191	209	221
11–11.9	186	190	202	223	244	261	280	159	165	173	183	195	205	230
12–12.9	193	200	214	232	254	282	303	167	171	182	195	210	223	241
13–13.9	194	211	228	247	263	286	301	172	179	196	211	226	238	245
14–14.9	220	226	237	253	283	303	322	189	199	212	223	240	260	264
15–15.9	222	229	244	264	284	311	320	199	204	218	237	254	266	272
16–16.9	244	248	262	278	303	324	343	213	225	234	249	269	287	296
17–17.9	246	253	267	285	308	336	347	224	231	245	258	273	294	312
18–18.9	245	260	276	297	321	353	379	226	237	252	264	283	298	324
19–24.9	262	272	288	308	331	355	372	238	245	257	273	289	309	321
25–34.9	271	282	300	319	342	362	375	243	250	264	279	298	314	326
35–44.9	278	287	305	326	345	363	374	247	255	269	286	302	318	327
45–54.9	267	281	301	322	342	362	376	239	249	265	281	300	315	326
55–64.9	258	273	296	317	336	355	369	236	245	260	278	295	310	320
65–74.9	248	263	285	307	325	344	355	223	235	251	268	284	298	306
Females														
1–1.9	138	142	148	156	164	172	177	105	111	117	124	132	139	143
2–2.9	142	145	152	160	167	176	184	111	114	119	126	133	142	147
3–3.9	143	150	158	167	175	183	189	113	119	124	132	140	146	152
4–4.9	149	154	160	169	177	184	191	115	121	128	136	144	152	157
5–5.9	153	157	165	175	185	203	211	125	128	134	142	151	159	165
6–6.9	156	162	170	176	187	204	211	130	133	138	145	154	166	171
7–7.9	164	167	174	183	199	216	231	129	135	142	151	160	171	176
8–8.9	168	172	183	195	214	247	261	138	140	151	160	171	183	194
9–9.9	178	182	194	211	224	251	260	147	150	158	167	180	194	198
10–10.9	174	182	193	210	228	251	265	148	150	159	170	180	190	197
11–11.9	185	194	208	224	248	276	303	150	158	171	181	196	217	223
12–12.9	194	203	216	237	256	282	294	162	166	180	191	201	214	220
13–13.9	202	211	223	243	271	301	338	169	175	183	198	211	226	240
14–14.9	214	223	237	252	272	304	322	174	179	190	201	216	232	247
15–15.9	208	221	239	254	279	300	322	175	178	189	202	215	228	244
16–16.9	218	224	241	258	283	318	334	170	180	190	202	216	234	249
17–17.9	220	227	241	264	295	324	350	175	183	194	205	221	239	257
18–18.9	222	227	241	258	281	312	325	174	179	191	202	215	237	245
19–24.9	221	230	247	265	290	319	345	179	185	195	207	221	236	249
25–34.9	233	240	256	277	304	342	368	183	188	199	212	228	246	264
35–44.9	241	251	267	290	317	356	378	186	192	205	218	236	257	272
45–54.9	242	256	274	299	328	362	384	187	193	206	220	238	260	274
55–64.9	243	257	280	303	335	367	385	187	196	209	225	244	266	280
65–74.9	240	252	274	299	326	356	373	185	195	208	225	244	264	279

Appendix D

Regression Analysis: HbA_{1c} as a Predictor of Anthropometric Parameters

Regression analysis: HbA_{1c} as a predictor of height, weight, TSF, SSF, MAMC and weight:height ratio.

Dependent Variable	Sex	Regression Equation	$*r^2$
Height	males	y = 21.6 + 6.40 x	.370
	females	y = 60.3 - .593 x	.001
	entire group	y = 18.9 + 2.90 x	.040
Weight	males	y = 1.45 + 5.36 x	.20
	females	y = 26.3 + 2.26 x	.022
	entire group	y = 15.87 + 3.46 x	.060
TSF	males	y = 32.10 + 3.90 x	.150
	females	y = 69.3 + 11.30 x	.40
	entire group	y = 11.4 + 7.0 x	.230
SSF	males	y = 94.5 + 1.10 x	.020
	females	y = 45.1 + 1.80 x	.020
	entire group	y = 76.8 + 0.26 x	.001
MAMC	males	y = 41.10 + 0.33 x	.001
	females	y = 122.2 - 6.28 x	.127
	entire group	y = 79.4 + 2.90 x	.038
Weight:Height Ratio	males	y = 1.59 + 3.20 x	
	females	y = 1.73 + 0.28 x	.050
	entire group	y = 0.89 + 0.140x	.024

*Coefficient of determination

Appendix E

Regression Analysis: Age at Onset as a Predictor of HbA_{1c} and Anthropometric Parameters

Regression analysis: age at onset of diabetes as a predictor of HbA_{1c}, height, weight, TSF, SSF, MAMC and weight:height ratio.

Dependent Variable	Sex	Regression Equation	$*r^2$
HbA_{1c}	males	y = 9.90 + 0.198 x	.110
	females	y = 11.40 + 0.119 x	.044
	entire group	y = 11.07 + 0.119 x	.045
Height	males	y = 28.21 + 2.82 x	.198
	females	y = 55.13 - 0.29 x	.001
	entire group	y = 44.09 + 1.16 x	.022
Weight	males	y = 51.98 + 1.04 x	.020
	females	y = 63.49 - 1.30 x	.023
	entire group	y = 55.87 + 0.195 x	.001
TSF	males	y = 91.80 - 1.60 x	.070
	females	y = 56.60 + 1.69 x	.028
	entire group	y = 68.75 + 0.494 x	.004
SSF	males	y = 78.70 + 0.32 x	.005
	females	y = 102.40 - 4.87 x	.410
	entire group	y = 85.69 + 1. 47 x	.053
MAMC	males	y = 33.10 + 1. 30 x	.038
	females	y = 48.75 - 0.498 x	.003
	entire group	y = 42.38 + 0.331 x	.002

(continued)

Dependent Variable	Sex	Regression Equation	*r^2
Weight:Height ratio	males	y = 1.76 + 0.06 x	.183
	females	y = 2.83 - 0.15 x	.046
	entire	y = 2.48 + 0.121 x	.058

*Coefficient of determination

Appendix F

Regression Analysis: Duration of Disease as a Predictor of HbA_{1c} and Anthropometric Parameters

Regression analysis: duration of diabetes as a predictor of HbA_{1c}, height, weight, TSF, SSF, MAMC and weight:height ratio.

Dependent Variable	Sex	Regression Equation	$*r^2$
HbA_{1c}	males	y = 11.15 + 0.198 x	.084
	females	y = 11.48 + 0.182 x	.120
	entire group	y = 11.29 + 0.197 x	.160
Height Percentile	males	y = 48.99 + 1.71 x	.056
	females	y = 64.67 + 2.65 x	.091
	entire group	y = 57.26 + 0.996 x	.015
Weight Percentile	males	y = 53.17 + 2.80 x	.120
	females	y = 51.92 + 0.448 x	.004
	entire group	y = 53.6 + 1.03 x	.017
TSF Percentile	males	y = 67.91 + 3. 20 x	.214
	females	y = 66.2 + 0.610 x	.004
	entire group	y = 68.25 + 1.20 x	.021
SSF Percentile	males	y = 78.40 + 1.070 x	.042
	females	y = 47.37 + 4.50 x	.426
	entire group	y = 64.17 + 2.56 x	.150
MAMC	males	y = 39.90 + 1.71 x	.051
	females	y = 34.08 + 2.52 x	.076

(continued)

Dependent Variable	Sex	Regression Equation	$*r^2$
	entire group	y = 37.14 + 2.12 x	.064
Weight:Height Ratio	males	y = 1.10 + 0.036 x	.051
	females	y = 0.191 + 0.350 x	.287
	entire group	y = 0. 60 + 0.239 x	.211

*Coefficient of determination

Appendix G

Correlation Matrix: Males

Correlation matrix for males: duration, HbA_{1c}, age at onset of diabetes and height.

1	1.000	0.3481	-	0.5275	-	0.3012
2	1.000	0.2092	0	0.0352		
3	1.000	-0.0298				
4	1.000					

where:

1=duration 3=age at onset
2=HbA_{1c} 4=height

Appendix H

Correlation Matrix: Females

Correlation matrix for females: duration, HbA_{1c}, age at onset of diabetes and height.

1	1.000	0.2893	-0.6762	0.2353
2	1.000	0.3333	0.6055	
3	1.000	0.4446		
4	1.000			

where:

1=duration 3=age at onset
2=HbA_{1c} 4=height

Appendix I

Analysis of Variance and Means to Determine Day-to-Day Variability

Analysis of variance of three-day calorie intake.

ANOVA Calories

Source	df	MS	F	Significance of F
Sex	1	6,409,785	*10.368	.00429
Subject/sex	20	618,203		
Day	2	155,215	.738	.485
Sex x day	2	175,339	.833	.442
Error	40	210,405		

*significant at α = .00429

Means: three-day calorie intake of males and females.

Sex	*n	Day I	**s	Day II	s	Day III	s
Males	10	2792	145.1	2467	145.1	2718	145.1
Females	12	1999	132.4	2030	132.4	2070	132.4

*n = number of subjects

**± Standard deviation of the mean

Appendix J

Analysis of Variance and Means to Determine Day-to-Day Variability: Protein

Analysis of variance of three-day protein intake.

ANOVA Protein

Source	df	MS	F	Significance of F
Sex	1	17,616	*11.44	.00296
Subject/sex	20	1,540		
Day	2	273	.476	.625
Sex x day	2	285	.496	.613
Error	40	574		

*Significant at $\alpha = .00296$

Means: three-day protein intake of males and females.

Sex	*n	Day I	**s	Day II	s	Day III	s
Males	10	125.8	7.58	115.3	7.58	112.9	7.58
Females	12	84.7	6.92	87.4	6.92	83.5	6.92

*n = number of subjects.

**± Standard deviation of the mean.

Appendix K

Analysis of Variance and Means to Determine Day-to-Day Variability: Fat

Analysis of variance of three day fat intake.

ANOVA Fat

Source	df	MS	F	Significance of F
Sex	1	28,549	*11.9	.0023
Subject/sex	20	2,168		
Day	2	1,290	1.74	.188
Sex x day	2	1,593	2.15	.129
Error	40	740		

*Significant at α = .0025

Means: three-day fat intake of males and females.

Sex	*n	Day I	**s	Day II	s	Day III	s
Males	10	133.9	8.6	107.5	8.6	125.9	8.6
Females	12	74.8	7.9	80.8	7.9	92.5	7.9

*n = number of subjects.

**±Standard deviation of the mean.

Appendix L

Analysis of Variance and Means to Determine Day-to-Day Variability: Carbohydrate

Analysis of variance of three-day carbohydrate intake.

ANOVA Carbohydrate

Source	df	MS	F	Significance of F
Sex	1	16,617	*1.998	.1729
Subject/sex	20	8,318		
Day	2	674	.228	.797
Sex x day	2	2,450	.831	.443
Error	40	2,950		

*Not significant at $\alpha = .05$

Means: three-day carbohydrate intake of males and females.

Sex	*n	Day I	**s	Day II	s	Day III	s
Males	10	276	17.2	266	17.2	289	17.2
Females	12	257	15.7	245	15.7	233	15.7

*n = number of subjects

**± Standard deviation of the mean

Appendix M

Range of Energy, Protein, Fat and Carbohydrate of Males and Females

Range* of energy, protein, fat and carbohydrate intake and HbA_{1c} of males with IDDM.

Subject (#)	Energy (kcal)	Protein (grams)	Fat (grams)	Carbohydrate (grams)	HbA_{1c} (%)
01	51	13.6	13	17.0	10.0
07	1258	24.6	102.1	58.2	8.0
02	119	14.1	31.4	56.4	12.8
05	672	22.8	41.1	97.3	11.0
06	1259	46.5	56.3	31.1	10.3
03	987	25.1	69.4	39.8	13.0
04	1808	152.9	105.7	161.1	14.3
08	714	31.2	38.3	41.9	11.0
10	744	59.8	43.3	39.8	13.0
09	1200	50.5	56.9	121.0	14.0

*Calculated by subtracting the least amount of a nutrient consumed from the greatest amount of that nutrient consumed over the three-day period.

Range* of energy, protein, fat and carbohydrate intake and HbA_{1c} of females with IDDM.

Subject (#)	Energy (kcal)	Protein (grams)	Fat (grams)	Carbohydrate (grams)	HbA_{1c} (%)
13	936	43.4	38.2	108.8	12.0
20	201	18.9	24.9	41.7	10.3
12	877	4.2	70.8	76.0	12.3
11	31	5.1	31.0	33.6	10.0
14	1072	26.0	87.6	45.5	13.0
17	516	20.2	30.0	73.6	13.0
18	470	58.9	32.8	45.8	9.0
15	637	30.2	66.8	46.6	12.0
16	702	18.3	28.5	136.9	14.0
22	1125	15.9	34.8	249.4	15.0
19	806	26.8	19.4	145.2	14.0
21	352	14.7	19.3	75.1	13.0

*Calculated by subtracting the least amount of a nutrient consumed from the greatest amount of that nutrient consumed over the three-day period.

Appendix N

Regression Analysis: Ranges of Nutrient Intakes as Predictors of HbA_{1c}

Linear regression analysis: ranges of three-day intakes of kcalories, protein, fat and carbohydrate as predictors of HbA_{1c}.

Independent variable	Regression Equation	*r	**r^2
Calories	y = -194.378 + 78.630 x	.327	.107
Protein	y = -7.980 + 3.397 x	.204	.041
Fat	y = 49.589 - 0.186 x	-.013	.0002
Carbohydrate	y = -161.524 + 20.005 x	.670	.449

*Coefficient of determination.

**Correlation coefficient

Appendix O

Raw Data for Calculation of P:S Ratio

Raw data for calculation of P:S ratios.

Males		Females	
Total Polyunsaturates (g)	Saturated Fat (g)	Total Polyunsaturates (g)	Saturated Fat (g)
3.8	22.4	3.1	18.1
11.5	47.1	5.1	11.7
3.6	19.8	2.4	22.9
18.9	37.6	4.9	37.1
12.1	31.0	6.5	29.7
7.8	28.7	6.8	14.3
15.6	43.6	17.0	34.2
11.2	33.9	12.6	14.8
10.1	35.5	13.7	31.8
5.7	29.1	7.6	30.6
		4.3	21.7
		3.7	24.1

Appendix P

1980 Recommended Dietary Allowances

1980 Recommended Dietary Allowances

FOOD AND NUTRITION BOARD, NATIONAL ACADEMY OF SCIENCES–NATIONAL RESEARCH COUNCIL
RECOMMENDED DAILY DIETARY ALLOWANCES,[a] Revised 1980
Designed for the maintenance of good nutrition of practically all healthy people in the U.S.A.

							Fat-Soluble Vitamins			Water-Soluble Vitamins							Minerals					
	Age (years)	Weight (kg)	Weight (lb)	Height (cm)	Height (in)	Protein (g)	Vitamin A (μg RE)[b]	Vitamin D (μg)[c]	Vitamin E (mg α-TE)[d]	Vitamin C (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg NE)[e]	Vitamin B-6 (mg)	Folacin[f] (μg)	Vitamin B-12 (μg)	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Iron (mg)	Zinc (mg)	Iodine (μg)
Infants	0.0–0.5	6	13	60	24	kg × 2.2	420	10	3	35	0.3	0.4	6	0.3	30	0.5[g]	360	240	50	10	3	40
	0.5–1.0	9	20	71	28	kg × 2.0	400	10	4	35	0.5	0.6	8	0.6	45	1.5	540	360	70	15	5	50
Children	1–3	13	29	90	35	23	400	10	5	45	0.7	0.8	9	0.9	100	2.0	800	800	150	15	10	70
	4–6	20	44	112	44	30	500	10	6	45	0.9	1.0	11	1.3	200	2.5	800	800	200	10	10	90
	7–10	28	62	132	52	34	700	10	7	45	1.2	1.4	16	1.6	300	3.0	800	800	250	10	10	120
Males	11–14	45	99	157	62	45	1000	10	8	50	1.4	1.6	18	1.8	400	3.0	1200	1200	350	18	15	150
	15–18	66	145	176	69	56	1000	10	10	60	1.4	1.7	18	2.0	400	3.0	1200	1200	400	18	15	150
	19–22	70	154	177	70	56	1000	7.5	10	60	1.5	1.7	19	2.2	400	3.0	800	800	350	10	15	150
	23–50	70	154	178	70	56	1000	5	10	60	1.4	1.6	18	2.2	400	3.0	800	800	350	10	15	150
	51+	70	154	178	70	56	1000	5	10	60	1.2	1.4	16	2.2	400	3.0	800	800	350	10	15	150
Females	11–14	46	101	157	62	46	800	10	8	50	1.1	1.3	15	1.8	400	3.0	1200	1200	300	18	15	150
	15–18	55	120	163	64	46	800	10	8	60	1.1	1.3	14	2.0	400	3.0	1200	1200	300	18	15	150
	19–22	55	120	163	64	44	800	7.5	8	60	1.1	1.3	14	2.0	400	3.0	800	800	300	18	15	150
	23–50	55	120	163	64	44	800	5	8	60	1.0	1.2	13	2.0	400	3.0	800	800	300	18	15	150
	51+	55	120	163	64	44	800	5	8	60	1.0	1.2	13	2.0	400	3.0	800	800	300	10	15	150
Pregnant						+30	+200	+5	+2	+20	+0.4	+0.3	+2	+0.6	+400	+1.0	+400	+400	+150	h	+5	+25
Lactating						+20	+400	+5	+3	+40	+0.5	+0.5	+5	+0.5	+100	+1.0	+400	+400	+150	h	+10	+50

[a] The allowances are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined. See text for detailed discussion of allowances and of nutrients not tabulated. See Table 1 (p. 20) for weights and heights by individual year of age. See Table 3 (p. 23) for suggested average energy intakes.

[b] Retinol equivalents. 1 retinol equivalent = 1 μg retinol or 6 μg β carotene. See text for calculation of vitamin A activity of diets as retinol equivalents.

[c] As cholecalciferol. 10 μg cholecalciferol = 400 IU of vitamin D.

[d] α-tocopherol equivalents. 1 mg d-α tocopherol = 1 α-TE. See text for variation in allowances and calculation of vitamin E activity of the diet as α-tocopherol equivalents.

[e] 1 NE (niacin equivalent) is equal to 1 mg of niacin or 60 mg of dietary tryptophan.

[f] The folacin allowances refer to dietary sources as determined by *Lactobacillus casei* assay after treatment with enzymes (conjugases) to make polyglutamyl forms of the vitamin available to the test organism.

[g] The recommended dietary allowance for vitamin B-12 in infants is based on average concentration of the vitamin in human milk. The allowances after weaning are based on energy intake (as recommended by the American Academy of Pediatrics) and consideration of other factors, such as intestinal absorption; see text.

[h] The increased requirement during pregnancy cannot be met by the iron content of habitual American diets nor by the existing iron stores of many women; therefore the use of 30–60 mg of supplemental iron is recommended. Iron needs during lactation are not substantially different from those of nonpregnant women, but continued supplementation of the mother for 2-3 months after parturition is advisable in order to replenish stores depleted by pregnancy.