DIETARY INTAKES
AND PHYSICAL ACTIVITY
IN A SAMPLE OF CHILDREN IN SASKATOON

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ABSTRACT

Diet and physical activity are modifiable human behaviors and play important roles in children's health. Almost all diet and physical activity studies in children have examined diet or physical activity separately and have not looked at these two factors together in the same sample of children. This study was carried out to investigate both diet and physical activity in a group of children to better understand the relationship of diet and physical activity, as well as to collect healthy reference data for future studies in clinical child populations.

Fifty children (26 females and 24 males) ages ranging from 6 to 15 years, living in Saskatoon were recruited for the study. Mean ages, heights, weights, head circumferences and tricep skinfold thicknesses of male and female children were not significantly different to each other. Male children had significantly higher energy, carbohydrate, protein, and fat intakes. Energy intakes of males and females were low compared to literature values. Thirty one (62%) children were below adequate intake (AI) for calcium and the number of children below AI for vitamin D was 16 (38%). Thirty two (64%) children were below estimated average requirement (EAR) for vitamin E.

There was no difference in the level of physical activity between male and female children when using Physical activity questionnaire for older children (PAQ-C), activity diary, and Caltrac. Twenty percent of children was obese and this was similar to the North American reported values. Both males (-192 ± 610 kcal) and females (- 410 ± 393 kcal) had a apparent negative energy balance with a significantly greater negative balance observed in females ($p<0.05$).

Twenty children (40%) were underreporters at the energy intake (EI) to the estimated resting energy expenditure ratio of less than 1.1, the cut off level. Underreporters had significantly higher mean age (11.1 ± 2.9 years) and BMI (18.8 ± 2.8 kg/m^2) than normal reporters (8.7 ± 2.1 years and 16.28 ± 2.5 kg/m^2). Also, underreporters' mean energy intakes (1258 ± 193 kcal) and physical activity (PAQ-C)

rating: 2.69 ± 0.62) were lower than normal reporters (1610 ± 372 kcal and PAQ-C rating: 3.03 ± 0.51) . No association was found between underreporting and children's sex or BMI.

The difference in male and female children's nutrient intakes, mainly energy intake, was due to their sex differences and cannot be attributed to their underreporting, anthropometry or levels of physical activities. Underreporting would have reduced apparent mean energy and other nutrient intakes. The level of nutrient intakes and physical activity were adequate except inadequacies observed in relation to calcium, vitamin D, vitamin A, and vitamin E intakes. Increase in vegetable and fruit, and milk products up to the Canada's Food Guide's minimum recommended levels is recommended to reduce the vitamin D, vitamin A, and vitamin E inadequacies.

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LIST OF ABBREVIATIONS

AI - Adequate Intake

BMI - body mass index

BMR - basal metabolic rate

DFE - dietary folate equivalents

DLW - doubly labelled water

DRI - Dietary Reference Intake

EAR - Estimated Reference Intake

EI - energy intake

EI/BMR_{est} - ratio of energy intake to estimated basal metabolic rate

EI/REE_{est} - ratio of energy intake to estimated resting energy expenditure

FNB - Food and Nutrition Board

HC - head circumference

MET- ratio of work metabolic to resting metabolic rate energy expenditure

NHANES - National Health and Nutrition Examination Survey

PAQ-C- Physical Activity Questionnaire for older Children

PEI - Probability Estimate of Inadequacy

PT- Pushparajah Thavarajah

RDA - Recommended Dietary Allowance

REE - resting energy expenditure

RNI - Recommended Nutrient Intake

SES - socio-economic status

SL - Shanda Lingelbach

TEE - total energy expenditure

TSF - tricep skinfold thickness

UL - Upper Limit

US - United States

WHO- World Health Organization

Wt - weight

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1. INTRODUCTION

1.1. Rationale

Diet and physical activity are modifiable human behaviors. These two behaviors, that develop during childhood (Berenson, 1986), have a direct effect on health. Epidemiologic evidence suggests poor diet and sedentary life styles increase the risk of obesity, cardiovascular diseases, cancers and orthopedic problems (Troiano,1998). Obesity is one of the most serious problems facing North American children (Bar-Or, 1998). Poor diet and low physical activity during childhood can lead to serious health consequences in adulthood; yet a better diet and increased physical activity themselves can significantly counteract these health problems (Gortmaker, Dietz, & Sobol,1987; Paffenbarger, Blair, Lee, & Hyde, 1993).

Most studies of children examined either diet or physical activity (Whiting, Colleaux, & Bacchetto, 1995; Shatenstein & Ghadirian, 1996; Kovalski, Crocker &Faulkner, 1997). The results of these studies do not lead to a better understanding of the relationship between diet and physical activity in the same population. To the best of our knowledge, only one study (Deheeger, Rolland-Cachera, & Fontvieille,1997) investigated both diet and physical activity using the same population of children. The age of the children in this study was 10 years. Therefore, a study investigating a wider age range is needed to better understand the relationship between diet and physical activity in children.

The purpose of this study was to evaluate young (aged 6 to 15 years) healthy children's dietary intakes using three 24-hour dietary recalls and physical activity level using the Physical Activity Questionnaire for older Children (PAQ-C), activity diary, and Caltrac. These data collected could then be used as healthy reference standards in comparison with clinical sample groups.

1.2. Objectives of this study were to evaluate

1. dietary intakes using three 24-hour recalls to determine types of food and amount of nutrients in the diet of young healthy children; and

2. physical activity level using PAQ-C , activity diary, and Caltrac in the same children.

3. energy balance using dietary energy intakes and energy expenditure through physical activity and estimated energy expenditure.

2. LITERATURE REVIEW

2.1. Obesity prevalence, factors, and prevention

Obesity is a disease of epidemic proportions with increasing prevalence worldwide in adults and children (WHO, 1997). Obesity is defined, usually as percentage of body fat and weight for height ratios such as body mass or ponderal index. The second National Health and Nutrition Examination Survey (NHANES), found that 27.1% of children 6 to 11 years of age and 21.9% of adolescents 12 to 17 years of age were obese (Gortmaker et al., 1987). There was an increase in prevalence of obesity among the adolescents for the period of 1976-1980 (Control, 1994). An analysis of secular trends suggests an increase in body weight and adiposity in children. Between 1973 and 1994 in the United States, the mean weight of a child at any given height and age increased by 0.2 kg per year (Freedman, Srinivasan, Valdez, Williamson, & Berenson, 1997). The prevalence of childhood obesity in Canada ranges from 7% to 43% (Periodic Health Examination, 1994). This wide range of results is due to different measures that were used to measure obesity. In some studies, self-reports and in other studies objective measures such as skinfold thickness and BMIs have been used. Therefore, a range of obesity prevalence rates in Canada has been reported. It has been estimated that costs associated with the increasing prevalence of obesity and associated health risks to be approximately $100 billion per year in the United States (Wolf & Colditz, 1998). All these show that prevalence of obesity is rising and increasing the burden to the individual and society.

Obesity is a complex multi-factorial trait that evolves under the interaction of influences from the social, behavioral, physiological, metabolic, cellular, and molecular domains (Bar-Or, Foreyt, Bouchard, Brownell, & Dietz, 1998). Fewer than 5% of obese children have an underlying disease that causes obesity (Bar-Or et al., 1998). The cause of obesity for the rest is a result of an imbalance between energy intake and expenditure.

The average energy intake of young healthy children has been declining during the last 4 decades (Bar-Or et al., 1998). Although calorie dense foods were abundant, the

calories from fat has continued to go in a downward trend since 1960s (Bar-Or et al., 1998). The NHANES data from the United States indicate a decrease in calorie intake among children and young adolescents (Troiano & Flegal, 1998). Although, fat and energy intake have been declining, children and adolescents still consume greater than the recommended 30% of calories from fat (Goran, Reynolds, & Lindquist, 1999). In relation to vegetable and fruit servings, the estimates indicate that only approximately 7-30% of United States children eat five or more fruit and vegetables per day (Goran et al., 1999).

Energy, other nutrient intakes, and physical activity together determine the level of growth and general level of health of a person. The Canada's Food Guide to Healthy Eating (Health and Welfare Canada, 1992) recommends this type and number of servings of food types that an individual should eat for health living. The guide places foods into four groups: grain products, vegetables and fruits, milk products, meats and alternatives. This Guide suggests a way of eating for people over the age of 4 years with how much (servings) from each group to eat every day. Depending on the age and level of physical activity the guide suggests 5 to 12 servings per day of grain products, 5 to 10 servings per day of vegetables and fruit, 2 to 4 servings of milk products and 2 to 3 servings per day of meat and alternatives.

Energy balance is the difference between energy intake and expenditure. A positive energy balance is required for the energy requirement of growth in children. However excess energy can increase weight and obesity. In adults obesity and weight gain can be treated with diet, physical activity, pharmacotherapy, and surgery. However, these latter methods are not appropriate for children. Also, while very low kilocalorie diets can reduce the energy intake, this method is not suitable for children since it may impair their growth and development (Periodic Health Examination, 1994). Therefore, the main methods of treating childhood obesity include modification of diet or exercise, diet and exercise together (Periodic Health Examination, 1994).

Physical activity is the most variable component of an individual's energy expenditure. A study of high school students found that participation in physical

education declined from 1984 to 1990 (Heath, Pratt, Warren, & Kann, 1994). Physical activity in children occurs less frequently and with less intensity than recommended (Goran et al., 1999). Some of the reasons for declining children's physical activity include changes in safety in children's physical activity environments, parental work habits, television viewing, availability of video games, and other cultural aspects of the environment. These factors may have decreased opportunities for exercise and, thus reduced level of physical activity in children (Gutin & Manos, 1993).

Canada's Physical Activity Guide to Healthy Active Living (Health Canada, 1998) is the guide for active living. This guide describes three activity groups: endurance activities, flexibility activities, strength activities. This Guide suggests endurance activities 4 to 7 days a week, flexibility activities 4 to 7 days a week and strength activities 2 to 4 days a week. Some of the endurance activities include walking, yard and garden work, cycling, skating, continuous swimming, tennis and dancing. Flexibility activities include gardening, yard work, bowling, yoga, dance and curling. Strength activities include heavy yard work, raking and carrying leaves, climbing stairs, wearing a backpack, weight/strength training routines.

Both Canada's Food Guide and Physical Activity Guide are the recommendations for optimum eating and physical activity for any individual. These guides were prepared for the purpose of reducing obesity, other health related risks and for healthy living. Also, diet and physical activity play an important role can significantly change an individual's energy balance in terms of energy intakes and expenditures.

2.2. Anthropometry in children

Anthropometry is the measurement of physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition (Jelliffe, 1966). The measurements of physical dimensions include height, weight, knee height, head circumference, and frame size. These measurements are important indicators of

children's growth and their general level of health. The physical dimensions can be combined to obtain anthropometry indices. The most commonly used anthropometric indices are weight-for-height (Must, Dallal, & Dietz, 1991; WHO, 1995). These indices are expressed in terms of percentiles, percent of median and Z-scores. Percentiles are the rank position of an individual on a given reference distribution and are used in clinical situations. However, the main disadvantage of percentiles is that in the extremes of the reference distribution there is little change in percentile values even when there is a substantial change in the index. Percent of median is the ratio of a measured value in the individual, to the median value of the reference data for the same age or height, expressed as percentage. Z-score is the deviation of the value for an individual from the mean value of the reference population, divided by the standard deviation for the reference population. Unlike the others, this allows the mean and standard deviation to be calculated for a group of Z-scores.

Body Mass Index (BMI) is weight/ height^2. BMI is a single index of body mass that can be applied to assess overweight (WHO, 1995) and is a reliable and widely used indicator (Sizonenko & Himes, 1993). The BMI provides a reasonable measure of fatness in children and adolescents. BMIs above the 85th percentile can be used as screening of overweight and above the 95th as an indication of excess adiposity in children (Dietz & Bellizzi, 1999). The main advantage of BMI is its applicability in many situations, since measures of height and weight can be obtained with reasonable precision in field, clinical, and research settings (Troiano, Flegal, Kuczmarski, & Campbell, 1995).

Skinfold thickness is a measure of fatness. Subcutaneous fat constitutes a large part of total body fat; the proportion of subcutaneous fat to body fat varies with age, sex, and degree of adiposity. Tricep skinfold thickness (TSF) is positively correlated with the percentage of subcutaneous fat (Dietz & Bellizzi, 1999). Although the use of skinfold-thickness measurements has some methodological problems such as obtaining accurate measurements and accurately predicting the level of body fat in obese subjects, TSF is the best anthropometric indicator of percentage of fat in children (Roche, Siervogel,

Chumlea, & Webb, 1981).

Head circumference is a measurement to detect abnormalities of head and brain growth. The head circumference of a child increases rapidly during the first 12 months of life, then growth is slower by age 36 months (Roche & Himes, 1980). This measurement is most frequently obtained in clinical setting as part of health screening for potential developmental or neurological disturbances in children. Both small and large (i.e. below 5% and above 95%) head circumferences are indicative of health or developmental risk (WHO, 1995).

2.3. Energy requirement and expenditure

Energy is required for human physiological functions and physical activity. The level of energy requirement depends on an individual's age, sex, body size, genetic factors, physiological state, pathological condition and on ambient temperature. The World Health Organization (WHO) defines energy requirement as,

> the level of energy intake from food which will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long-term health; and which will allow for the maintenance of economically necessary and socially desirable physical activity (WHO, 1985).

Growth is a continuous process in children. The rate of growth varies with age, being very rapid during the first year of life, and then declining with age. Another rapid growth spurt occurs during adolescence and continues until puberty. The WHO defines energy requirement for growth in children as, "the energy needs associated with the deposition of tissues at rates consistent with good health" (WHO, 1985). It has been estimated that approximately 5 kcal are required per gram of tissue gain, which is about 1% of an individual's total energy requirement (Roberts & Young, 1988). Therefore additional energy is required for children's growth other than their maintenance requirements.

Energy expenditure can be explained as any form of energy loss from the body. Energy expenditure at rest and during physical activity are the main components and energy spent at rest is the largest component of an individual's total energy expenditure. Resting energy spent under thermal neutral conditions is described as resting energy expenditure (REE) and may include energy used for digestion and absorption. When REE is measured soon after awakening in the morning, at least 12 hours after the last meal is referred as the basal metabolic rate (BMR) (WHO, 1985). Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell, & Christenson, 1985). Physical activity occurs at different times with different levels of intensity. After REE, physical activity is the second largest component of an individual's energy expenditure. The metabolic rate increases after eating depend on the size and composition of the meal. This can be referred as diet-induced thermogenesis and it reaches a maximum approximately after one hour after the meal consumed and disappears after four hours (Garrow, 1978).

Other factors such as environmental temperature and carrying extra loads also increase the level of energy expenditure. It has been found in adults that energy expenditure during work is approximately 5% higher in a mean temperature below 14^0C (Johnson, 1963). The increased energy expenditure is associated with carrying extra weights of cold-weather clothing and footwear. Also, the energy expenditure is high in adults when they perform heavy work at temperatures 37^0C or higher (Johnson, 1963). Although information is not available for children, it can be assumed that children also spend a proportionate amount of extra energy when playing outside at low and high temperatures and carrying their school bags to school and back home. All these factors are collectively important in determining an individual's level of energy requirement, expenditure, and energy balance.

2.4. Dietary intake data, assessment, and requirement in children

2.4.1. Dietary intakes of children

The last time dietary intake of children was measured on a national level was by a survey carried out by Nutrition Canada from 1970 to 1972 (Canada, 1973). The results of this survey indicated that diets of many infants, children, and adolescents were inadequate. In particular a large proportion of children five to nine years old had inadequate intakes of calcium and vitamin D (Canada, 1973). Adolescent girls ages ten to nineteen years old had inadequate intakes of iron, calcium, vitamin D, and boys in the same age category had inadequate intakes of calcium and vitamin D. Although dietary intake studies on children have been carried out elsewhere, only 3 recent studies looked at children's nutrition in Canada (Whiting, Colleaux, & Bacchetto, 1995; Shatenstein & Ghadirian, 1996; Donovan & Gibson, 1996). Table 2.1 summarizes the main findings of these 3 studies.

A study carried out in Saskatoon with 226 children ages 8 to 15 years using up to six 24-hour dietary recalls to estimate dietary intakes, found low intakes of vitamin A and zinc in males, and low intakes of vitamin A, zinc, calcium, folate, and riboflavin in females (Whiting et al., 1995). The inadequacy of nutrients was determined by using the probability estimate of inadequacy (PEI), and more than 15% of at least one age group of girls was at risk for inadequate intakes of vitamin A, calcium, zinc, folate, iron, thiamin and riboflavin, and for boys vitamin A, zinc, calcium and folate. The intake was below the recommended number of servings of 1992 Canada's Food Guide to Healthy Eating for vegetables and fruits or milk products. This was the reason for the inadequacy of vitamin A, calcium, folate and riboflavin. Also, it was found that underreporting resulted in a reduction of the mean energy intakes and this may have increased apparent inadequacies of some nutrients in the female middle age group (10-12 years) to older age group (13 to 15 years).

Another study, performed in Montreal using 182 French Canadian children ages 5 to 18 years found that almost all micro nutrient intakes surpassed their respective age

and sex specific 1990 Canadian Recommended Nutrient Intakes (RNIs) (Shatenstein & Ghadirian, 1996). Also, calcium was most frequently found below the 66% of age sex specific RNI cutoffs.

A study carried out by Donovan and Gibson (1996) determined the energy and nutrient intakes of omnivorous and vegetarian female adolescents aged 14 to 19 years. This study used three-day weighed food records and found lacto-ovo-vegetarians (defined as individuals who consumed red meat less than once a month, but included poultry and/ or fish in their diets more than once a month) and semi-vegetarians were more at risk for nutrient inadequacies than omnivorous females.

Table 2.1.Summary of studies investigating children's dietary intakes in Canada

Authors, Place	No. of Subjects and Age	Dietary method	Results
Whiting, Colleaux, & Bacchetto (1995), Saskatoon, Canada	111 Males 115 Females Age: 8 -15 years	Six 24-hour recalls	No difference in dietary adequacy of nutrients between supplement users and non-users. Mean intakes of most nutrients met or exceeded RNI levels. The PEI indicated 25% risk of vitamin A, calcium, zinc, folate and riboflavin by girls and vitamin A and zinc by girls and boys.
Shatenstein & Ghadirian. (1996), Montreal, Canada	81 Males 101 Females Age: 5 -18 years	Seven day food record	Children consume generally adequate diets, energy intake under the recommended level, no growth problems suggesting sub optimal activity levels. Ca intake was below adequate level.
Donovan and Gibson, (1996) Southern Ontario, Canada	122 females Age: 14 - 19 years	Food Frequency Questionnaire and Weighed food records for 3 days	Lacto-ovo-vegetarians and semi-vegetarians were more at risk for nutrient inadequacies than omnivores (OM).

2.4.2. Dietary intakes assessment

Nutritional status assessment can be performed by using a combination of dietary, biochemical, anthropometric and clinical methods (Gibson, 1990). Dietary assessment alone does not provide complete information about the nutritional status of individuals or groups. However, dietary assessment provides estimates of adequacy of dietary intakes and information on food supply, and can be used to evaluate education programs of dietary interventions at the individual and group levels (Lee & Nieman, 1996). For research and clinical purposes, individual dietary intakes can be assessed by using 24-hour recall, diet history, duplicate food collections, food account, direct observation, and a food frequency questionnaire (Lee & Nieman, 1996).

The 24-hour dietary recall is the most commonly used method for assessing actual food intakes (Cox, 1990). It is a valid tool for obtaining actual food intakes at the group level for a wide range of ages, social backgrounds and occupations (Karvetti & Knuts, 1985). Single 24-hour recalls can be used to estimate group average intakes and multiple (3 or more) 24-hour recalls can be used to estimate actual intake of an individual. This technique is quick, easy and has a low subject burden (Cox, 1990). In 24-hour dietary recalls, the individual is asked to recall the types and amounts of food and beverages he or she consumed during the last 24 hours. Two- or three-dimensional food models can be used to represent portion sizes in 24-hour recalls. These models help the respondent estimate portion sizes accurately, and enhance the accuracy of the self-report (Guthrie, 1984).

A person's food intake varies day to day, season to season, and depending on the availability of foods. Therefore, a single day recall of an individual may not precisely represent his or her usual intake. A single 24-hour recalls cannot be used to assess an individual's usual intake (Beaton et al.,1979). The multiple 24-hour recalls can be used to obtain intakes of several days and thereby estimate usual intakes of an individual.

However, a large number of one-day individual 24-hour recalls can be used to assess group nutrient intake (Hartman, Brown, & Palmgren, 1990).

The 24-hour recall can be used to estimate children's dietary intakes. Children can perform their own 24-hour recalls, with accuracy that improves with age (Whiting & Shrestha, 1993). However, younger children may not be able to recall all foods consumed. In those situations, a parent or caregiver can assist in recalling and estimating the young children's food portion sizes. In a study on children's 24 hour dietary intakes, children with their parents as a group (consensus reporting) provided intakes that were highly correlated with direct observation (Eck, Klesges, & Hanson, 1989). Therefore, 24-hour recalls can be used to assess children's dietary intakes with the assistance of a parents or caregivers or without assistance for older children. However, the 24- hour recall is an interview technique, and is associated with inherent under and over reporting problems due to recall errors (Karvetti & Knuts, 1985). Common foods such as bread, potatoes, and coffee are easy to recall and food items such as side dishes are easily forgotten (Karvetti & Knuts, 1985). This may likely cause omissions and additions of recalled food items (Karvetti & Knuts, 1985).

The 24-hour recalls can also be obtained through telephone interviews. Telephone surveys are as good as, and may be better than, other methods for obtaining dietary information (Fox, Heimendinger, & Block, 1992). The validity of using telephone interviews in dietary recalls have been tested (Krantzler, Mullen, Schutz, Grivetti, & Holden, 1982; Posner, Borman, Johnnie, & Ohls, 1982). It has been shown that the dietary recalls through telephone interviews have produced accurate and acceptable estimates of nutrient intakes (Krantzler et al., 1982). However these studies have been conducted using adult populations. The main advantages of telephone administered 24-hour recalls over the face to face interview includes low cost, time, logistical, and personnel requirements (Posner et al., 1982).

Among the other methods, diet history is a more precise method and involves an extensive interview with a trained interviewer regarding his or her typical diet. One week of diet history is a highly valid method in assessing young adults dietary intakes (Van-Stavreren, de Boer, & Burema, 1985). Also this is a suitable method for assessing the diets of children (Livingstone, Coward, & Prentice, 1992). However, this method has some limitations. The reported intakes from diet history give higher intakes. Also, there is a significant variation between the interviewers in assessing individuals' usual intakes (Black et al., 1993) and causes significant subject burden.

A food frequency questionnaire is a checklist of foods consumed over time. The individual asked to estimate how often he or she eats each item using a pre-determined scale (Gibson, 1990). From this, an estimate of usual dietary intake can be calculated. This method has low subject burden, is inexpensive and assesses the usual intake levels of both individuals and groups with a high response rate. The disadvantages of this method are that the type of foods and portions listed may not always be clear, it is less precise for estimating absolute amounts of nutrients compared to other methods, depends on memory and calculation skills, and it may miss nutrients due to grouping of different foods. Whiting and Shrestha (1993) found that semi-quantitative food frequency questionnaire was not reliably filled by children aged 7-10 years. This was due to children's inability to grasp abstract concepts such as serving per week before they reach 11 years of age.

Duplicate food collections involve collecting an identical portion of all food and beverages consumed for a specified period of time (Lee & Nieman, 1996). An individual is asked to have two portions. One portion is eaten by the individual and the other one collected into a container. The portion collected into the container is chemically analysed for nutrients present in food. This method does not rely on the food composition tables and involves no coding errors in computer-based diet analysis. Although the duplicate food collection method is more accurate for nutrient consumption, it involves increased

subject burden in collecting and sending food portions for laboratory analysis. This method is the most expensive and is not feasible for population studies (Lee & Nieman, 1996).

In direct observation, an observer records what an individual eats and drinks for a particular period. This method is accurate since recording prevents any losses of information due to an individual's memory losses. Also, the observer can monitor the plate waste. Direct observation is an expensive method and can be done only in an institutional setting.

Food account is a record of the use of foods in household or institutional settings. An inventory is made for a specified period to determine usage. Per capita intakes can be obtained by dividing the usage by the total number of people. This is a convenient method to assess the usual intakes of individuals in institutions and could cover many people for a longer period of time with a lower cost (Lee & Nieman, 1996).

2.4.3. Evaluating nutrient intakes

Dietary Reference Intakes (DRIs) provide recommendations for nutrients applicable to North Americans and are the quantitative estimates of nutrient intake levels for healthy people. Four primary uses of DRIs are to assess nutrient intakes of individuals, assess intakes of population groups, plan diets for individuals, and plan diets for groups. The DRIs include RDAs, Estimated Average Requirement (EAR) Adequate Intake (AI), and Tolerable Upper Intake Level (UL). The EAR is the amount of nutrient which has been estimated to meet the nutrient requirement of 50% of the healthy individuals in a life stage and gender group (Yates et al., 1998). The EAR is used to assess adequacy of intakes of individuals and groups and to derive RDAs. The RDA of a nutrient is the EAR for that nutrient plus two standard deviations of EAR, where the nutrient's standard deviation of the EAR is available and distributed normally. However,

when standard deviation cannot be determined for a nutrient, a coefficient of variation of 10% or 15% (in the case of niacin) can be assumed. Therefore, the RDA for that nutrient is 1.2 or 1.3 times the EAR.

An AI is set for a nutrient where there is no scientifically valid information to determine an EAR. It is the level of intake in a group of healthy individuals based on the observed or experimentally determined estimates (Yates et al., 1998). The UL is the highest level of daily intake which does not pose any risks of adverse health effects for almost all healthy individuals in the general population (Yates et al., 1998). The upper limits for these nutrients are not the recommended intakes; the risk of adverse effects increases when an intake exceeds the upper limit.

The DRIs for calcium, phosphorous, magnesium, fluoride, thiamin, riboflavin, niacin, vitamin B6, pantothenic acid, biotin, choline, vitamin C, vitamin E, selenium, beta-carotene and carotenoid have been published (Food and Nutrition Board, 1998 and 2000). For each age and sex group of children ages 6 to 15 years, the EAR values for micronutrients except calcium and vitamin D are given in Table 2.2. The AI values for calcium and vitamin D are in Table 2.3.

Table 2.2. Estimated Average Requirements of micronutrients except Calcium and Vitamin D for children

Nutrient	**Male**			**Female**		
Age (years)	4-8	9-13	14-18	4-8	9-13	14-18
Thiamin(mg/d)	0.6	0.9	1.2	0.6	0.9	1
Niacin (NE/d)[a]	8	12	16	8	12	14
Riboflavin (mg/d)	0.6	0.9	1.3	0.6	0.9	1
Vitamin B6 (mg/d)	0.6	1	1.3	0.6	1	1.2
Vitamin B12 (µg/d)	1.2	1.8	2.4	1.2	1.8	2.4
Vitamin A (RE/d)[b]	275	445	630	275	420	485
Vitamin C (mg/d)	25	45	75	25	45	65
Vitamin E (mg/d)	7	11	15	7	11	15
Iron (mg/d)	4.1	5.9	7.7	4.1	5.7	7.9
Magnesium(mg/d)	130	240	410	130	240	360
Zinc (mg/d)	4	7	8.5	4	7	7.5

a. As niacin equivalent (NE)

b. As retinol equivalent (RE)

Table 2.3. Adequate Intakes of Calcium, and Vitamin D for Children

Nutrient	**Male**			**Female**		
Age (years)	4-8	9-13	14-18	4-8	9-13	14-18
Calcium (mg/d)	800	1300	1300	800	1300	1300
Vitamin D [a,b] (µg/d)	5	5	5	5	5	5

a. 1µg = 40 IU vitamin D

b. In the absence of adequate sunlight

2.4.4. Underreporting of dietary intakes in adult studies and of children

Underreporting is a serious limitation in nutritional studies in using self reported dietary assessment data. This is a tendency for individuals or groups to report consuming less energy than their actual intakes. Underreporting can be determined by estimating energy expenditure or predicted based on age, height, and weights. Urinary nitrogen analysis methods can be used to determine the actual protein intake of an individual and thereby to determine underreporting. However, these are difficult to use in dietary surveys because methods are expensive, technically more demanding, and increase subject burden.

Underreporting of energy intake (EI) has been reported in children (Bandini, Cyr, Must, & Dietz, 1997; Carter, 1999; Livingstone et al., 1992). The ratio of energy intakes (EI) and estimated basal metabolic rate (BMR_{est}) have been used to determine children's underreporting (Carter, 1999). When an individual's energy intake is below the minimum EI:BMR_{est} ratio, it is incompatible with long term maintenance of energy balance of that individual for his or her long-term survival (Goldberg et al., 1991). The total energy expenditure (TEE), energy intakes, and EI/TEE ratios from 4 studies of children are presented in Table 2.4 (Goldberg et al., 1991). These EI/TEE ratios can be set the cutoff limits to determine energy underreporting in children. This is inexpensive and quickly identifies the obviously implausible reported energy intakes.

In adults, the most common types of diets that are underreported are snack foods between meals, high carbohydrate foods, and added sugar foods (Poppitt, Swann, Black, & Prentice, 1997). These foods are rich in carbohydrates and underreporting of carbohydrates lowers the level of actual energy intakes. Adult underreporters tend to report a diet with a higher proportion of energy from protein and lower proportion from carbohydrate (Poppitt et al., 1997). In relation to the characteristics of adult underreporters, dietary surveys have found that high body mass index is associated with a greater probability of low reported energy intake (Pryer, Vrijheid, Nicols, Kiggins, & Elliot, 1997). Under-reporting is more prevalent in obese and post-obese individuals, and

increases with age (Bandini et al., 1997; Black et al., 1993).

The possible types of foods that children underreport have not been reported in the literature. However the reasons for children's underreporting have been reported (Bandini et al., 1997). Older children spend more time outside their homes and consume a greater proportion of their diet in places other than their home. This is a significant reason why in these children forget what they actually consumed. The lack of methods to assess or weigh the foods outside the home may cause errors in estimating and reporting the actual intakes (Bandini et al., 1997). In relation to the characteristics of underreporting in children, a study done at the University of Saskatchewan (Carter, 1999) reported that approximately 25% of the children had EI: $BMR_{estimated}$ <1. In this study it was shown that children with higher ponderal index (kg/m^3) were more likely to be under-reporters. Also, a female's age was positively associated with the odds of under-reporting, but not for males (Carter, 1999).

Table 2.4. Energy intake(EI), total energy expenditure (TEE), and EI/TEE values for children assessed using diet history[a]

The number of children	**Age range** (years)	**EI**[b] kcal/d (MJ/d) Mean ± SD	**TEE**[c] kcal/d (MJ/d) Mean ± SD	**EI/TEE** Mean +SD
20	3-5	1.49 ± 0.16 6.29 ± 0.71	1.37 ± 0.26 5.76 ± 1.12	1.12 ± 0.19
24	7-9	2.11 ± 0.65 8.88 ± 1.45	1.95 ± 0.33 8.20 ± 1.42	1.10 ± 0.16
12	12	2.84 ± 0.48 11.96 ± 2.04	2.50 ± 0.26 10.54 ± 1.10	1.14 ± 0.17
22	15-18	2.89 ± 0.75 12.17 ± 3.18	2.98 ± 0.82 12.52 ± 3.48	1.00 ± 0.21

a. Modified from Black et al. (1991)

b. EI = Energy intake

c. TEE= Total energy expenditure

2.5. Physical activity data, assessment, and methods in children

2.5.1. Physical activity data and assessment in children

The levels of physical activity in children depend on many factors. Physical activity varies from child to child, as well as for a given child over time. Activity patterns depend on sex, age, physical location and season. A study involving high school students reported that participation in physical education declined from 1984 to 1990 (Heath et al., 1994). In general, boys are more active than girls (Pate, Long, & Health, 1994; Sallis, 1993). Both boys' and girls' activity patterns decrease with age and decreases in activity levels start during the second decade (Freedman & Melanson, 1996) with the activity of females declining more rapidly (Sallis, 1993). In relation to effects of seasons, it has been found that Canadian children and adolescents are more active in the summer (Stephens, 1993).

Studies using the Physical Activity Questionnaire for older Children (PAQ-C), involving children in Saskatoon ages 9 to 15 years found that boys were more active than girls and both boys' and girls' activity patterns were higher in the spring compared to late fall and winter (Crocker et al., 1997). However, in another study in Saskatoon involving grades four to eight children using eight measures found no difference in male and female physical activities, except with the Caltrac measure (Kowalski, 1997) .

In relation to the amount of children's energy expenditure on physical activities, it has been estimated that about 400 kcal/day is used by young children in physical activity-related energy expenditure under free-living conditions (Goran, 1995; Livingstone et al., 1992).

Table 2.5. Summary of studies investigating children's physical activity in Canada

Authors, Place	**No. of Subjects and Age**	**Physical activity method(s)**	**Results**
Crocker et al. (1997) Saskatoon, Canada	Study I: 125 Males 90 Females Study II: 43 Males 41 Females Age: 9-15 years	PAQ-C	PAQ-C is a cost efficient method to assess the children's physical activity
Kowalski et al. (1997), Saskatoon, Canada	Study I: 38 Males 51 Females Study II: 41 Males 56 Females Age : NA (4-8 grade)	PAQ-C, Behavioral conduct, Athletic competence, Activity rating, Teacher's rating, Seven day recall, Leisure time exercise questionnaire, Canadian home fitness test	PAQ-C is a valid method to assess children's physical activity
Holowachuk, (1998), Saskatoon, Canada	20 Males 24 Females Age: NA (4-8 grade)	Tritrac Caltrac	Tritrac was highly correlated to Caltrac, Tritrac is not correlated to PAQ-C

a. NA= Not available

Children's physical activity behaviours are diverse and may include play, chores, organized sports, exercise and unorganized activities. All these activities are interconnected with different dimensions of body movements. No single method is available to determine the different aspects of physical activity, and a physical activity measuring instrument measures only the component of physical activity it was designed to measure (Baranowski,1988). Therefore, the use of a single instrument to assess children's physical activity may not reflect all the aspects of their physical activity domain.

In relation to the assessing younger children's physical activity, children may not be able to estimate their time accurately. Young children do not wear watches, and their days are organized for them by school and parents. Third and fourth grade children and younger children were more likely to report difficulty in remembering their events (Baranowski et al., 1984). Some younger children may be equally active as older children and vice versa. Saris (1985) proposed the use of combination of physical activity methods to overcome these difficulties in assessing children's physical activity. Also, it has been shown that the use of one instrument does prevent the younger children from being classified as equally active as the older children (Freedman & Melanson, 1996). The more instruments used, the better the estimation of different aspects of physical activity and actual level of children's physical activity. Table 2.6 presents a summary of the suggested physical activity instruments relative to the study population which were used to estimate daily physical activity in children (Saris, 1985).

Table 2.6. Combination of methods to assess children's physical activity[a]

Number of Children	Method
> 100	-simple questionnaire about regular activities child/ parent/ teacher
	-movement counter
20 - 100	-heart rate monitoring
	-movement counter
< 20	-doubly labelled water
	-heart rate monitoring
	-indirect calorimetry
	-observation

a. Modified from Saris (1985)

2.5.2. Methods to assess physical activity in children

Assessment of physical activity provides information on individual or group physical activity levels and is useful in program planning, intervention, and providing services and facilities for individuals and groups (Hensley, Ainsworth, & Ansorge, 1993). More than 30 different methods have been used to assess physical activity. All of them can be broadly categorized into 4 major types: self report measures, mechanical and electronic monitoring, direct observation, and physiological measures.

2.5.2.1 Self report methods, Physical Activity Questionnaire for older Children (PAQ-C) and activity diary

Self reports are the most widely used method to obtain physical activity data. They are relatively quick, easy to obtain, inexpensive, unobtrusive and non-reactive (Baranowski, 1988). The self reports can be categorised into four types depending on the method of obtaining information. They are interview-administered recalls, self-administered recall, diary and proxy reports. Interview administered recalls, an interviewer records the recalls of activities for a specified duration through a structured question- and-answer session, one-on-one with the respondent. In self administered recalls, the respondent reports his or her activities on a questionnaire without an interviewer. In the diary, the respondent lists all his or her activities throughout a specified time period. In the proxy reports, the parent or teacher or both record the activity of an individual. Self reports can assess duration, intensity and frequency of the activity over a particular time interval, the physical location (e.g., at home, at school), the social environment (who is around), and reasons for activity-intensity. These types of information are unavailable from physiological measures such as doubly-labelled water and heart rate monitoring since they cannot provide such detailed behavioural information (Baranowski, 1985). Accuracy of self reports is a limitation due to the potential for recall errors, but accuracy can be improved by training individuals for

questionnaire completion, giving written instructions, and improving clarity of the form.

The Physical Activity Questioners fo older Children (PAQ-C) is a self report method which can be used to assess moderate to vigorous levels of physical activity in children ages 9 to 15 years (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). The PAQ-C has 11 items, of which nine are used to calculate summary activity scores. The other two items assess whether sickness or other events prevented the child doing his or her regular physical activities. Each PAQ-C item is scored on a five-point scale. The higher scores indicate higher levels of physical activity. The first item is an activity checklist consisting of common sports, leisure activities and games with extra space to list other activities. Six items assess activity in physical education classes, recess, lunch, right after school, in the evenings, and on the weekend. One item is the statement "describes you best for the last 7 days" with five statements describing low to very high activity levels. The last item asks the child how often he or she did physical activity for each day of the week. The consistency of responses in each item and inter-item correlations have tested and shown that the PAQ-C is a valid instrument (Crocker et al., 1997). The testing and retesting of PAQ-C with school children have provided ratings that were reliable and accurate with children's general levels of physical activity(Crocker et al., 1997). It is significantly related to other activity measures such as motion sensors, and interview administered activity recalls (Sallis, Buono, Roby, Micale, & Nelson, 1993; Sallis, Patterson, Buono, & Nader, 1988; Simons-Morton et al., 1990). The PAQ-C is a cost effective and convenient method to assess children's physical activity (Crocker et al., 1997). However, this is a self report measure which relies on the ability to recall and is subject to memory errors (Baranowski, Dworkin, & Cieslik, 1984; Laporte, Montoye, & Caspersen, 1985). The PAQ-C cannot be used to assess physical activity during holidays and special school events due to a potential change in children's usual physical activity patterns (Crocker et al., 1997). Also, the physical activity of some very active individuals may be underestimated by the use of PAQ-C because it is not useful in providing type and intensities of activities (Crocker et al., 1997). Therefore, PAQ-C cannot be used in all situations, and is designed only to measure children's

general levels during the school year (Crocker et al., 1997).

The physical activity diary is a self report method which provides a good estimate of energy expenditure (Kalkwarf, 1989). In activity diaries, the respondent can enter his or her types of activity with durations. The advantage of diaries over the other self report methods is that children can make their entries immediately after they engage in physical activities, with virtually no problems or errors in recall. Therefore, the activity diary provides an opportunity for these children to record their activities without problems of memory loss. It has been shown that an activity record of three days is an alternative method to assess population level energy expenditures. In this study, 150 children ages 10 years and older recorded their activities for 3 days and accurately estimated the energy expenditures (Deheeger et al., 1997). However, the activity diary increases subject burden and has limitations in use in the long term epidemiological studies (Deheeger et al., 1997).

2.5.2.2 Caltrac

The Caltrac is an electronic, single plane accelerometer designed to reflect total quantity and intensity of vertical acceleration of the body. It is a small device that can be worn around the waist or on the hip. The Caltrac measures the activity level by an internal transducer that records any body acceleration. Depend on the force by body acceleration, a charge is produced that could be converted to counts or calories. The number of counts or calories expended depend on the level of physical activity or an individual's age, height, weight and sex. The number of counts can be transformed to the amount of kilocalorie expenditure by multiplying 0.101 kcal/kg per count (Sallis, Buono, Roby, Carlson, & Nelson, 1990).

Studies performed to compare energy cost of exercise in children ages 8 to 13 years who walked or ran on the treadmill at 3, 4, and 5 miles per hour while wearing Caltrac reported positive correlations with heart rate monitors (Sallis et al., 1990). The energy expenditure determined by the Caltrac was also similar to that determined by

observation in children (Sallis et al., 1990). However, use of Caltrac has some limitations in children's physical activity assessment. A study using Tritrac (which is similar in size and shape to Caltrac and records three dimensional movements) reported that 43% of children did not wear their Tritracs because of discomfort, interference with activity and official/ coaches instructions (Holowachuk, 1998). It was also reported that Tritrac was highly correlated with Caltrac and had no correlations to PAQ-C (Holowachuk, 1998). This was due to each was measuring the different aspects of physical activity. There have been no studies reported which use Caltrac in assessing energy expenditure in free-living children.

2.5.2.3. Other methods to assess physical activity

Direct observation is mostly used to test accuracy and validity of other physical activity assessing methods (Baranowski & Simons-Morton, 1991). In observation, the observer can record several dimensions of physical activity to quantify and classify different physical activity patterns. This method is most useful in assessing children's physical activity due to its non-invasive nature and no chance for errors in activity recalls. However, observation methods cannot determine the inter-individual variances in caloric expenditure or the true level of intensity (Melanson & Freedson, 1996). Other disadvantages include its observer errors, labour-intensiveness and high costs involved in time and observers.

3. METHODS

3.1. Subjects

Fifty children ages ranging from 6 to 15 years and living in city of Saskatoon participated in this study. Advertisements, email, word of mouth, personal contacts and a list of College of Pharmacy and Nutrition employees at University of Saskatchewan were used to recruit children for this study. Shanda Lingelbach (SL), a senior nutrition undergraduate student, assisted several aspects of the study, including contacting parents and in conducting 24-hour telephone interviews. Parents of the children were contacted, informed about the study, and consent was obtained by the researcher, Pushparajah Thavarajah (PT) and the research assistant (SL) personally or by telephone prior to speaking with their children. The purpose of this study with clear explanations was verbally provided. A parent and child had to sign a consent form before the child's participation in this study (Appendix A). Ethical approval for this study was obtained from the University of Saskatchewan Advisory Committee on Ethics in Behavioural Science Research (BSC #: 1999-110).

3.2. Experimental design and data collection procedure

A cross sectional, observational study was carried out which examined the dietary intake and physical activity of healthy young children aged 6 to 15 years living in Saskatoon. Three 24-hour dietary recalls were conducted to assess the types of diet and level of nutrient intakes children consumed. Level of physical activity was assessed using the Physical Activity Questionnaire for older Children (PAQ-C) and activity diary. Caltrac, a motion sensor and activity diary were used to assess energy expenditure. Subject information using a questionnaire (Appendix B) and anthropometric measurements were also collected. Four contacts were made. The initial one was to obtain subject information and anthropometric measurements, the first 24-hour recall,

and to provide instructions on physical activity instruments and Caltrac. The second and third contacts were made by telephone within a week period of the first contact to obtain two 24-hour recalls and to remind the child to wear Caltrac. The last contact was to obtain completed physical activity instruments, Caltrac, and other additional information such as recipes and brand names of foods that were unable to get over the phone. The dietary information was obtained for three usual days including a weekend day. This study was conducted from September 1999 to May 2000. School holidays and long weekends were avoided.

3.3. Data Collection

3.3.1. Anthropometry

The child's weight, height, head circumference and tricep skinfold thickness measurements were obtained by the researcher (PT) using the anthropometric measurement guidelines given in the Anthropometric Standardization Reference Manual (Lohman, 1988). The researcher was trained to obtain accurate anthropometric readings prior to the study by a certified trainer.

Weight was obtained using two weighing scales (Sunbeam, Toronto, Ontario) which were accurate within 100 g. The child was asked to stand still, without footwear, with light clothing and not touching anything on the center of the scale. The child was requested to keep both feet together and hands to their sides to distribute body weight evenly between both feet. Measurements were made to the nearest 100 g.

A steel tape was used to measure height. Children were asked to remove footwear and any hair pieces or pins to take the height accurately. The child was asked to stand with heels together at the base of the wall, and with toes pointed outward approximately sixty degrees. Legs were straight and arms to the side while shoulders relaxed. The head was positioned in the Frankfort Horizontal plane, such that plane from

the ear to the lower eye on the same side of the head was parallel to the floor and perpendicular to the wall. Both heels, the buttocks, the shoulder blades, and the back of the head were used as contact points and height was taken only when these points were sufficiently positioned against the wall. The child was asked to inhale deeply and to maintain an erect posture against the wall. The highest point of the head with sufficient pressure to compress the hair was determined in centimetres to the nearest 0.1 centimetre and the average of two height measurements was taken as the final height.

A flexible, non stretchable measuring tape made of vinyl was used to measure the head circumference. The child was asked to either sit or stand depend on the child's height to make an accurate measurement after removing any hair ornaments or pins. The tape was positioned in the same plane on both sides of the head just above the eyebrows, above (but not over) the ears, and centered over the occipital prominence, such that maximum circumference was located. The tape was pulled gently and firmly to compress the hair, and circumference was measured in centimetres to the nearest 0.1 centimetre. Two measurements of head circumference were taken and the average was used as the final head circumference.

Tricep skinfold measurements were obtained with the use of calipers (Creative Engineers, Inc., Plymouth, Michigan), based on the sites along the right side of the body. The child was asked to stand straight with the right arm flexed ninety degrees at the elbow with the palms facing upwards. The site was located on the posterior side of the arm, midway between the lateral projection of the acromion process of the scapula and the inferior margin of the olecranon process of the ulna. The midpoint between these two was marked along the lateral side of the arm. The located site was marked using a non-stretchable flexible tape. Standing behind the child, the researcher (PT) grasped the skin fold with the thumb and index finger of the left hand, measured the tricep skinfold with the calipers, and recorded the measurements. The calipers were held in the right-hand perpendicular to the long axis of the skin fold. The caliper's dial faced upward for easy

reading. The dial of the caliper was read three second after the caliper was applied. A minimum of two measurements were taken at least fifteen second apart. When the skin fold measurements were not within 0.4 millimetres of each other, a third measurement was taken and the closest two values were averaged. The TSF percentiles of this study group were determined according to the National Center for Health Statistics (1987) percentiles. The BMI percentiles were determined according to the Center for Disease Control growth charts (Roberts, 2001).

3.3.2. Twenty four-hour Dietary Recalls

Twenty four-hour dietary recalls were obtained for three days which included two weekdays and a weekend day from each child. For children aged 6 to 8 years, a parent was present and assisted the child during the dietary recalls. The first 24-hour recall was obtained during the first contact at the children's homes and the other two recalls were through two telephone interviews.

Saskatchewan Nutrition Survey Food Model Kits (College of Pharmacy and Nutrition, 1994) were used to assist the children in the estimation of the portion sizes. The components of the kit were explained to the children and parents of the younger children. The kit contained plates, bowls, mugs, cups, wood pieces of known dimensions, knives, spoons with plaster moulds to help to determine amounts and volumes of foods consumed. The kit also contained square, uniform, polyurethane discs which could be stacked to help with the estimation of food thickness, as well as polyurethane balls of varying diameters to help in estimate the portion sizes of foods. The plastic bowls and glasses had lines to divide them into quarters for more accurate description of food portion. All pieces in the model kit were marked with codes to facilitate quicker completion of the 24-hour recall form (Appendix C) and assist both child and the researcher (PT) and the research assistant (SL) in telephone interviews.The multiple-pass approach was used to obtain dietary intakes. This involved list of all foods consumed at the beginning and then a more detailed description of the each specific

item. Finally a review of the dietary information was carried out to make sure of the completeness and accuracy of all food intakes for the day. All information obtained through the 24-hour recalls were recorded onto the 24-hour recall form (Appendix C) according to the codes of the food models. The size, amount, or volume of every utensil, plate, bowl, etc. and every polyurethane disc and polystyrene ball in the kit had been previously determined for Saskatchewan Nutrition Survey conducted in 1993 and 1994. By matching the correct code with previously determined amount or volume for each code, the amount or volumes of the food or beverages were determined. When a food item did not match a model in the kit, the physical dimensions or volume of that food item was determined using measuring tapes and cups. A 24-hour dietary recall script (Appendix D) was used to keep consistency of 24-hour dietary recalls between children, and to obtain accurate intakes of foods and drinks.

3.3.3. Physical activity

3.3.3.1. Physical Activity Questionnaire for older Children (PAQ-C)

The PAQ-C assesses children's general level of physical activity and it is a summary of activities within the week of study period. The PAQ-C consists of 11 items (Appendix E). Nine items are used to calculate activity scores and the other two items (items 9 and 10) assess whether sickness or other events prevented the child from doing his or her regular physical activities during the study period. Item number 1 is a general activity checklist for all activities for one week. Item numbers 2, 3 and 4 are related to children's activities during physical education classes, recess, and lunch time. Item numbers 5, 6 and 7 are for after school, evening, and weekend activities. In item number 8 child describes best about his or her 7 days activities and number 11 is a week summary. Each question is rated from 1 to 5 scales where higher value is an indication of higher level of physical activity. The final PAQ-C is a mean rating of all 9 items.

3.3.3.2. Activity Diary

The activity diary is a structured diary for children to enter his or her activities for three days including a weekend day, assuming a child's day consisted of 16 hours (Appendix F). The children were provided verbal instructions on accurate completion of their diaries. Also, they were required to make entries as descriptively as possible to accurately convert their type of physical activities in to corresponding energy expenditures.

3.3.3.3. Caltrac

The Caltrac (Muscle Dynamics, Torrance, CA) was set to record the number of counts by the procedure suggested by Sallis et al., 1990 (Sallis et al., 1990). Verbal instructions on use and care of Caltrac were provided and children were requested to wear the given Caltrac on a convenient day within the study period. The instructions included when and when not to wear the sensor (e.g., in water) and proper positioning of the sensor on hip. The sensor was placed in a pouch, taped to prevent tampering and attached to a belt. Children were required to place the belt around the waist with Caltrac on the hip for one day and engage in whatever activity they desired for the chosen day. The children were requested to record the reading appeared on the caltrac monitor: at the beginning and at the end of the day.

The parents of younger children (age 6 to 8 years) were requested to assist their children to complete PAQ-C and Activity Diary, and to remind children to wear Caltrac throughout the day.

3.3.4. Other information

To obtain additional information on nutrition/diets and physical activity and children's general level of health an open-ended questionnaire was administered during

the initial contact. Age and sex of children was obtained for individual nutrition requirements and physical activity assessment. The criteria for children's health was determined by a question on Appendix B to parents to assess children's general level of health. The questions in the questionnaire asked whether or not the child had dieting recently, significant recent weight gains, food allergies and aversions, appetite, infections and/or on any other medical conditions.

3.4. Data analysis

3.4.1. Dietary intake

Foods listed in the 24-hour recalls were analysed using the Nutritionist IV (version 4.1) software program (First Data Bank, The Hearst Corporation, San Bruno, California) (Appendix G). Each food item was entered, and the search engine in the Nutritionist IV software program created a list of all foods containing the letters of the word entered. From this list, the most appropriate item was picked and then the measure and servings were chosen. When the measure of serving used in the program was not similar to the measure obtained by food model kits, the food item was purchased and then measured. Each recall day foods were entered separately and then average nutrient intake of the three days was calculated by the program. The number of food serving for grain products, vegetables and fruit, milk products, meat and alternatives, and other foods per day was determined according to the serving given in Canada's Food Guide to Healthy Eating. The nutrients of interest and food groups were selected for statistical analysis.

3.4.2. Physical activity

The responses for each item in PAQ-C, except item numbers 9 and 10 were rated on a 1 to 5 scale. These item ratings were taken for further statistical analysis.

The ratio of work metabolic rate to resting metabolic rate energy expenditure is

denoted as MET (Ainsworth, 1993). Energy expenditure of each activity was determined by multiplying each activity with its corresponding MET and the energy expenditure for each activity was in kilocalorie per activity per kg of body weight. Total energy expenditure for the day was determined by summing all activity related energy expenditure and then multiplying with body weight of the child.

The difference in the readings between Caltrac counts at the beginning and end of the day was taken as the total counts for activities for that day. Energy expenditure by Caltrac was determined for each child by multiplying the number of counts by 0.101 kcal/kg per count (Sallis et al., 1990).

3.4.3. Basal metabolic rate and underreporting

Basal metabolic rate (BMR) was estimated using World Health Organization (WHO), 1985 equations (WHO, 1985) for male and female children. The WHO equations use both age and body weight to calculate BMR_{est}.

For males

Age range 3-10 years :	BMR = (22.7 x wt) + 495	(equation 1)
10-18 years:	BMR = (17.5 x wt) + 651	(equation 2)

For females

Age range 3-10 years:	BMR = (22.5 x wt) + 499	(equation 3)
10-18 years:	BMR = (12.2 x wt) + 746	(equation 4)

where BMR = basal metabolic rate in kcal/day,

wt = weight in kilograms

The estimated BMR values (BMR_{est}) for children were used to determine the ratio of energy intakes(EI) to REE_{est} for each child. The EI/BMR_{est} ratios of 1.00 to 1.14 have been used in 4 studies to determine underreporting in children (Goldberg et al.,

1991). In this study we used $EI/BMR_{est}<1.10$ cutoff to identify underreporters considering age range, EI, REE_{est}, and sample sizes of the studies reported by Goldberg, 1991.

3.5. Statistical analysis

All statistical analyses were performed using the Statistical package for the Social Sciences (SPSS) program for Windows version 9.0 (1999).

Anthropometric data such as height, weight and head circumference were presented as means and standard deviations for total, males, and females. Independent sample t-tests were performed to test the significance of the difference between the mean anthropometric data for males and females. For macronutrients, micronutrient intake, and food servings for males and females intakes were presented as means and standard deviations and independent sample t-tests were performed to test the significance difference in mean nutrient intakes. The EARs (Institute of Medicine, 1997) were used to determine the adequacy. The EARs were used for iron, magnesium, phosphorous, zinc, vitamin A, E, B1, B2, B3, B12, C, and folate. The Ais were used for calcium and vitamin D.

The physical activity data were examined for the presence of outliers. The final PAQ-C rating was determined by averaging the values of 9 items in the PAQ-C. The average energy expenditure by activity dairy was determined by averaging the energy expenditures of three days. Independent sample t-tests were used to determine the significance of the difference in male and female physical activities by PAQ-C and energy expenditures by activity dairy and Caltrac. Correlation between physical activity instruments was examined through Pearson product moment correlations.

The significance difference of the characteristics such as age, BMI, energy intake and PAQ-C score between underreporters and normal reporters were determined by independent sample t-tests. The Chi square statistic was used to determine the association between underreporting and sex of children. The significance level for all

statistical tests was set for less than 0.05.

4. RESULTS

4.1. Recruitment, participation, and completion rates

The participation rate for children in this study was 77.5%. A total of 58 parents with children were contacted and 45 parents agreed to have their children participate in this study. A total of 51 children participated and 39 were from 39 parents and 12 from 6 parents. One child had a mild infection during the week of the study period. The study was conducted with this child because the child's parents were interested in participating in the study. However the data from this child was excluded from analysis. Children were recruited thorough personal communications (n=22), a list of employees with children from the College of Pharmacy and Nutrition, University of Saskatchewan (n=14) and thorough friends and relatives of graduate students, University of Saskatchewan (n=14). According to the criteria to determine children's health, none of the children had any significant medical related problems as reported by parents. Therefore, all remaining 50 children could be considered healthy according to the criteria designed for this study on children's general level of health. All children participated in providing their dietary information but during the study period not all children could complete anthropometric and physical activity fields. Missing data included triceps skinfold thickness (TSF) (n=4), activity diary (n=3), Physical Activity Questionnaire for Older Children (PAQ-C) (n=1), and Caltrac (n=4) measurements.

4.2. Subject characteristics, anthropometry, and body composition measurements

Characteristics of the 26 female and 24 male children are shown in Table 4.1. There was no significant difference in age of males and females (p=0.902).
Mean and standard deviations of heights, weights, body mass index (BMI), ponderal index, TSF and head circumferences for total group, males and females with SD are presented in Table 4.1. Male and female heights (p=0.517), weights (p=0.957), BMIs (p=0.627), ponderal index (p=0.678) and head circumferences (p=0.484) were not

significantly different from each other. The TSF percentiles of this study group with the number of males and females in each TSF percentile are presented in Figure 4.1. A higher number of females were in the <25th and 25-50th, equal number in 50-75th percentile range and a higher number of males were in > 75th TSF percentile range. Six males and 3 females were on risk of overweight (BMIs were above 85th percentile).

4.3. Dietary intakes and food types

Total energy, protein, carbohydrates, and total fat intakes with percent of total energy intake from carbohydrate, fat and protein are presented in Table 4.2. The fat intake of males was significantly higher than females ($p<0.002$) and no other statistically significant differences were found in macronutrient intakes between males and females. Calcium, iron, thiamin, riboflavin, niacin, folate, vitamin C, and vitamin A are presented in Table 4.3. Males' folate intake was significantly greater than females' ($p<0.015$).

Nutrient intakes were compared to Dietary Reference Intakes (DRIs) and Recommended Nutrient Intakes (RNIs). The number and percentage below EAR for thiamin, niacin, riboflavin, vitamin B6, vitamin B12, vitamin A, vitamin C, vitamin E, iron, and magnesium are given in Table 4.4. The number and percentage not meeting age and sex specific AI goal for Calcium, and vitamin D are given in Table 4.5.

Of those nutrients analyzed, the highest total number of children not reaching the established DRIs were found for calcium (n=31), vitamin D (n=19) and vitamin E (n=32). None of the subjects had intakes above upper limits.

The number of servings for total group, males, and females in each food group are given in Table 4.6. The number of servings for all food groups except milk products for 4 to 9 years age group are slightly lower than the lower recommended level for the daily servings.

4.4. Physical activity and energy balance

Values of the physical activity, assessed by Physical Activity Questionnaire-Children (PAQ-C), activity dairy and Caltrac are given in Table 4.7. The mean activity ratings from each PAQ-C item for males and females are presented in Figure 4.2. There was no significant difference between male and female physical activity levels as measured by PAQ-C ($p=0.095$), activity diary ($p=0.435$), and Caltrac ($p=0.864$).

Seven (14%) children the researcher (PT) had to reset the Caltrac on the first day they started wearing. Four children (8%) did not wear the Caltrac. For the activity diary, eight children (16%) started to enter their activities from the 2nd day. Three (6%) had missing data for at least one time interval. One child (2%) did not complete PAQ-C.

The correlation values between PAQ-C, activity diary, and Caltrac are given in Table 4.8 A statistically significant correlation was observed between Caltrac and activity diary using chi square analysis ($r=0.313$, $p<0.034$). Energy intake, resting energy expenditure (REE), activity energy expenditure assessed by activity diary and energy balance are presented in Table 4.9. There was a significant greater negative energy balance in females than in males ($p=0.044$).

4.5. Underreporting of energy intakes and characteristics of underreporters:

Of the 50 children in this study, 20 were identified as dietary energy underreporters (40% of total sample); 12 of them were females and 8 were males. The characteristics of underreporters and normal reporters are given in Table 4.10. There was no significant association between sex and number of underreporters from males and females ($p=0.263$). The distribution of EI/BMR to BMI is presented in Figure 4.3. The underreporters' age and BMI were significantly higher than the normal reporters ($p<0.001$ and $p<0.002$ respectively). The energy intake of underreporters was significantly lower than the normal reporters mean energy intakes ($p<0.001$). Also, the level of physical activity was significantly lower in underreporters than the normal

reporters (p=0.044).

4.6. Other information:

All the children participated in this study were healthy. None of the parents reported that their children had any changes in eating pattern, appetite, any allergies or was on a special diet. However, three children (6%) in this study group reported taking multivitamins at the times when they had infections. No one did report taking multivitamins or any other supplements during the study period.

Table 4.1. Age, height, weight, BMI, TSF and head circumference of total group, males, and females[a]

Variable	Total Group	Male	Female	p-value[e]
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years)	9.7 ± 2.7	9.7 ± 2.4	9.6 ± 2.9	0.902
Height (cm)	137.8 ± 17.2	139.4 ± 15.1	136.2 ± 19.0	0.517
Weight (kg)	34.3 ±13.7	34.4 ± 12.8	34.2 ± 14.8	0.957
BMI[b] ($kg.m^{-2}$)	17.3 ± 2.9	17.1 ± 2.8	17.5 ± 3.1	0.627
Ponderal Index ($kg.m^{-3}$)	12.5 ± 1.6	12.2 ± 1.5	12.8 ± 1.6	0.678
TSF[c] (mm)	11.8 ± 2.9	10.9 ± 2.9	12.6 ±2.7	0.050
HC[d] (cm)	53.5 ± 1.98	53.7 ± 1.8	53.3 ± 2.1	0.484

a. Expressed as mean and standard deviation

b. BMI=body mass index

c. TSF=tricep skinfold thickness

d. HC=head circumference

e. p-value=significance level by independent sample t-test between males and females

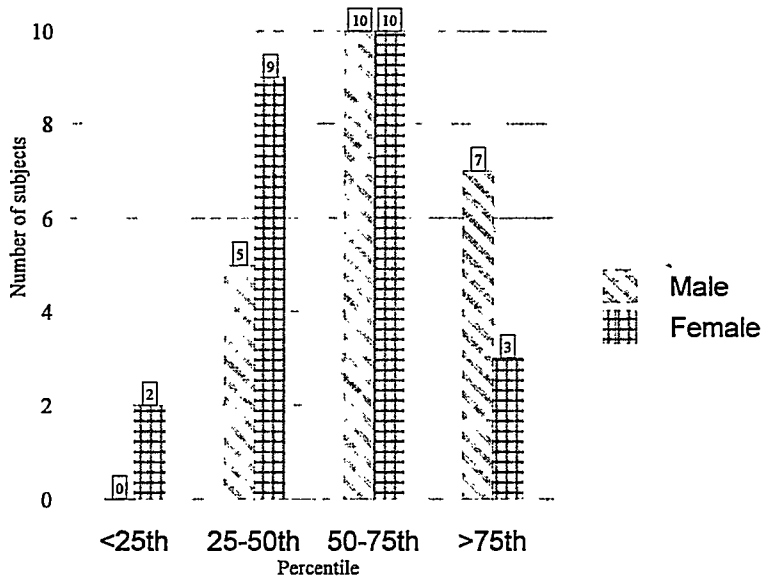

Figure 4.1. Comparison of males and females tricep skinfold thickness. Numbers above the bar represent the number of children in each percentile

Table 4.2. Macronutrient intakes for total group, males, and females[a]

Nutrient Intake	Total Group		Male		Female		p-value[b]
	Mean ± SD	% energy	Mean ± SD	% energy	Mean ± SD	% energy	
Energy (kcal)	1469 ± 356		1612 ± 371		1338 ± 289		0.006[c]
(MJ)	6.16 ± 1.49		6.77± 1.55		5.82 ± 1.21		
Protein(g)	56.3 ± 13.3	15.6 ±3.0	59.6 ± 14.0	14.7 ± 2.5	53.2 ± 12.1	15.9 ± 3.5	0.1
Carbohydrate(g)	206.4 ± 57.8	56.1 ±6.3	223.4 ± 60.8	55.5 ± 6.5	190.7 ± 51.1	56.7 ± 6.3	0.047[c]
Total Fat(g)	48.9 ± 16.1	29.6 ±5.3	55.8 ± 17.7	30.4 ± 5.7	42.5 ± 11.5	28.1 ± 4.6	0.003[c]
Fibre (g)	12.3 ± 4.6		12.9 ± 5.1		11.8 ± 4.1		

a. Expressed as mean, standard deviation, and percentage energy

b. p-value=significance level by independent sample t-test between males and females

Table 4.3. Micronutrient intakes for total group, males, and females[a]

Nutrient	Total Group	Male	Female	p-value[d]
	Mean ± SD	Mean ± SD	Mean ± SD	
Calcium (mg)	825 ± 337	872 ± 309	782 ± 362	0.349
Iron (mg)	11.7 ± 4.2	12.5 ± 4.2	11.0 ± 4.3	0.212
Thiamin (mg)	1.35 ± 0.50	1.47 ± 0.62	1.23 ± 0.34	0.108
Riboflavin (mg)	1.47 ± 0.38	1.54 ± 0.34	1.40 ± 0.41	0.215
Niacin[b] (NE)	13.5 ± 5.4	14.1 ± 4.3	13.0 ± 6.4	0.467
Folate (μg)	209 ± 91	231 ± 109	188 ± 65	0.015
Vitamin A[c] (RE)	1008 ± 788	1180 ± 888	849 ± 661	0.145
Vitamin C (mg)	95 ± 68	102 ± 66	88 ± 70	0.472
Vitamin E (mg)	4.99 ± 6.57	5.81 ± 7.61	4.23 ± 5.4	0.407
Magnesium (mg)	195 ± 67	204 ± 69	186 ± 64	0.346

a. Expressed as mean and standard deviation

b. Values in Niacin Equivalents

c. Values in Retinol Equivalents

d. p-value=significance level by independent sample t-test between males and females

Table 4.4. Number and percentage below EAR[a] for total group, males and females[b]

Nutrient	Total Group		Male		Female	
	# below EAR[c]	% below EAR[d]	# below EAR[c]	% below EAR[d]	# below EAR[c]	% below EAR[d]
Thiamin	8	16	5	10	3	6
Niacin	18	36	10	20	8	16
Riboflavin	4	8	4	8	0	0
Vitamin B6	13	26	7	14	6	12
Vitamin B12	6	12	2	4	4	8
Vitamin A	8	16	4	8	4	8
Vitamin C	11	22	4	8	7	14
Vitamin E	32	64	12	24	20	40
Iron	1	2	0	0	1	2
Mg	23	46	9	18	14	28
Zinc	26	52	13	26	13	26

a. EAR=Estimated Average Requirement

b. Expressed as number and percentage

c. # below EAR= number of children below EAR for males and females

d. % below EAR = percentage of children below EAR for male and females

Table 4.5. Number and percentage below AI[a] for total group, males and females[b]

Nutrient		Total # of subjects not meeting AI[c]	% of subjects not meeting AI[d]
Calcium:	**Male**	11	22
Calcium:	**Female**	20	40
Vitamin D:	**Male**	10	20
Vitamin D:	**Female**	9	18

a. AI= Adequate Intake

b. Expressed as number and percentage

c. # not meeting goal for age category= number of children not meeting AI goal for age category

d. Total # of subjects not meeting AI goal= Total number of children below AI for males and females

e. % of subjects not meeting AI goal= Percentage of children below AI for males and females

Table 4.6. Number of servings from each food group for total group, males and females[a]

Food Group[b]	Goal	Total Group Mean ± SD	Males Mean ± SD	Females Mean ± SD
Grain Products[c]	37022	4.6 ± 1.3	4.6 ± 1.4	4.6 ± 1.2
Vegetables and Fruit[c]	37020	3.4 ± 1.6	3.6 ± 1.6	3.4 ± 1.8
Milk Products[c]: 4-9[d]	2-3	2.1 ± 0.6	2.1 ± 0.5	1.9 ± 0.6
10-16[d]	3-4	2.1± 0.8	2.2 ± 0.4	2.0 ± 1.0
Meat and Alternatives[c]	36924	1.6 ±0.7	1.7 ± 0.7	1.5 ± 0.8
Other Foods[e]		5.3 ± 0.6	5.4 ± 0.5	5.3 ± 0.5

a. Expressed as mean and standard deviation

b. Values in number of servings per day

c. Determined according to Canada's Food Guide to Healthy Eating

d. Values in years

e. Other foods include foods that are not grouped under major food categories and their values are in numbers since there is no number of servings for foods in this category

Table 4.7. Level of physical activity for total group, males and females[a]

Instrument	Total Group Mean ± SD	Male Mean ± SD	Female Mean ± SD	p-value[d]
PAQ-C[b] (1-5 scale)	2.90 ± 0.57	3.03 ± 0.68	2.79 ± 0.45	0.095
Activity Diary[c] (kcal/day)	576 ± 244	570 ± 235	581 ± 258	0.435
Caltrac[c] (kcal/day)	1243 ± 707	1199 ± 611	1284 ± 795	0.864

a. Expressed as mean, standard deviations and range

b. PAQ-C= Physical Activity Questionnaire for older Children; values are in 1 to 5 scale.

c. Activity diary and Caltrac energy expenditures in kilo calories.

d. p-value=significance level by independent sample t-test between males and females

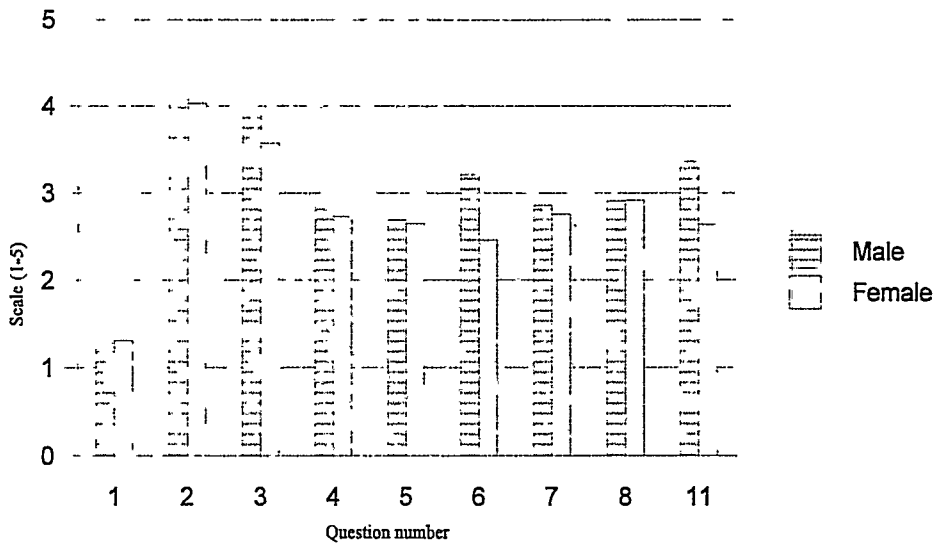

Figure 4.2. The average ratings for males and females for PAQ-C questions.

Table 4.8. Correlation coefficient matrix for PAQ-C[a], Activity Diary and Caltrac correlations

	PAQ-C[a]	**Activity Diary**	**Caltrac**
PAQ-C[a]	1	0.084	-0.328
Activity Diary	0.084	1	0.313[b]
Caltrac	-0.328	0.313[b]	1

a. Physical Activity Questionnaire for Older Children

b. Correlation is significant at $p<0.034$

Table 4.9. Energy intake, BMR, physical activity energy expenditure and energy balance for total group, males, and females[a]

Variable	Total Group	Male	Female	p-value[d]
	Mean ± SD	Mean ± SD	Mean ± SD	
Energy intake (kcal/day)	1469 ± 356	1612 ± 371	1338 ± 289	0.126
BMR (kcal/day)	1208 ± 223	1242 ± 236	1175 ± 211	0.812
Physical activity energy expenditure[b] (kcal/day)	576 ± 244	570 ± 235	581 ± 258	0.435
Energy balance[c] (kcal/day)	-303 ± 517	-192 ± 610	- 410 ± 393	0.044[d]

a. Expressed as mean and standard deviation

b. Physical activity energy expenditure based on activity diary

c. Energy balance is the difference between energy intake and estimated basal metabolic rate and physical activity related energy expenditure assessed by activity diary

d. p-value=significance level by independent sample t-test between males and females

Table 4.10. Characteristics of underreporters and normal reporters[a]

	Underreporters[d]	**Normal reporters**	**p-value[e]**
	Mean ± SD	Mean ± SD	
Age (years)	11.1 ± 2.9	8.7 ± 2.1	0.001
BMI[b] (kgm^{-2})	18.8 ± 2.8	16.2 ± 2.5	0.002
Energy Intake (kcal)	1258 ± 193	1610 ± 372	0.001
PAQ-C[c] (1-5 scale)	2.69 ± 0.62	3.03 ± 0.51	0.044

a. Expressed as mean and standard deviations

b. BMI = Body mass index

c. PAQ-C= Physical Activity Questionnaire for older Children

d. EI/BMR_{est} of 1.1 used as reference point to determine underreporting

e. p-value=significance level by independent sample t-test between underreporters and normal reporters

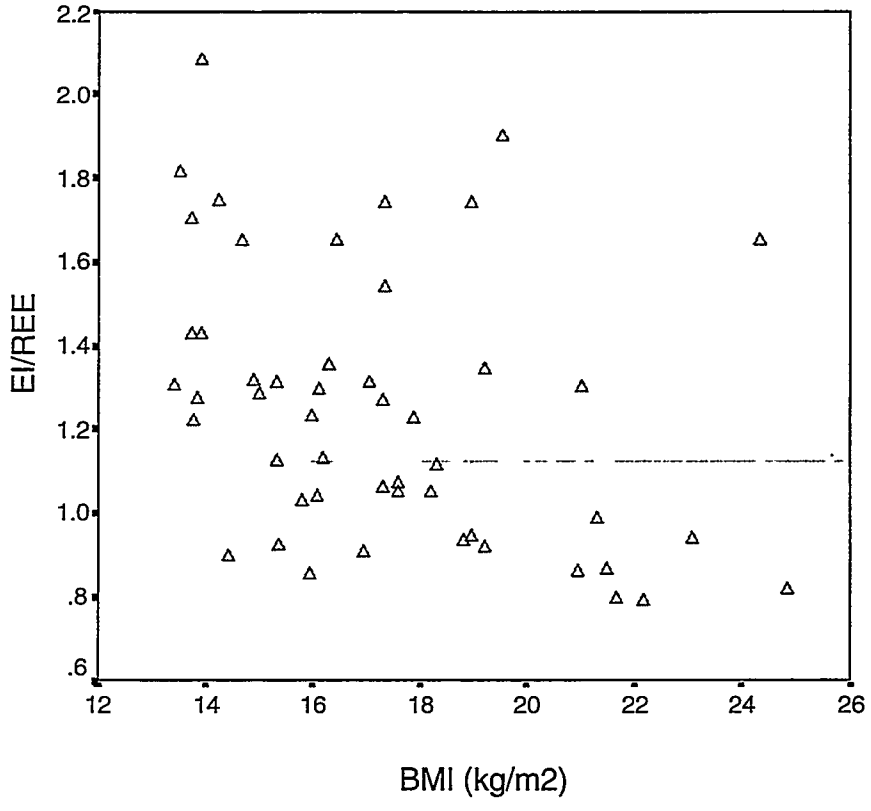

Figure 4.3. The distribution of current study group children's EI/BMR to BMI. The line at EI/BMR is 1.1 which is the cut off point between normal reporters and underreporters. The regression equation is EI/REE = -0.384 BMI + 21.667 and r is -0.384 ($p<0.006$)

5. DISCUSSION

The purpose of this study was to evaluate dietary intakes and physical activity of healthy children ages 6 to 15 years. Dietary intake was estimated using three 24-hour dietary recalls and physical activity level by using PAQ-C, activity diary and Caltrac. Energy balance was determined by the difference between energy intakes and expenditures. To the author's knowledge, this is the first study in Canada to evaluate both dietary intakes and physical activity using the same sample of children. The following discusses the results of this study in relation to other studies on diet or physical activity. Although there have been different dietary and physical activity studies on children conducted (Evers, 1995; Crawley, 1993; Nicklas et al., 1993; Absolon, Wearring, & Behme, 1988; Saris, 1985) we chose for comparison two dietary studies (Shatenstein & Ghadirian, 1996; Whiting et al., 1995) and four physical activity studies (Crocker et al., 1997; Johnson, Russ, & Goran, 1998; Kowalski, Crocker, & Faulkner, 1997; Sallis et al., 1990). This decision was based on age range of the study groups, type of dietary and physical activity instruments and the year of the study was conducted. These studies used 24 hour recalls to obtain dietary intakes and PAQ-C, Caltrac and Activity Diary to obtain physical activity data from children and all these study groups ages were comparable to the current study.

5.1. Evaluation of demographics, anthropometry, and other information

The total number of children participants in this study was 50: 24 males and 26 females and all were living in Saskatoon area. The participants in diet and physical activity studies (Crocker et al., 1997; Whiting et al., 1995) conducted in Saskatoon were also from Saskatoon area. In another study conducted in Montreal (Shatenstein & Ghadirian, 1996), all participants were selected from the Greater Montreal area. The male and female numbers of these three studies are given in Table 5.1.

Table 5.1. Subject characteristics of other diet and physical activity studies in Canada[a]

Variable	Current Study			Whiting study[b]		
	Total Group	Male	Female	Total Group	Male	Female
Number	50	24	26	226	111	115
Age (years)	6-15	6-15	6-15	8-15	8-15	8-15
Height[a] (cm)	109.2-175.2	139.7-175.2	109.2-175.2	NA	138.2-167.6	135.4-162.1
Weight[a] (kg)	16.3-76.3	18.1-70.9	16.3-76.3	32.1-55.6	32.1-55.6	32.1-54.6

a. Expressed as range

b. Whiting, Colleaux, & Bacchetto (1995)

c. Shatenstein and Ghadirian (1996)

d. Crocker et al (1997)

e. NA=Not available

Table 5.1. Continued

Variable	Shatenstein and Ghadirian study[c]			Crocker study[d]		
	Total Group	Male	Female	Total Group	Male	Female
Number	182	81	101	215 and 84	125 and 43	90 and 41
Age (years)	5-18	5-18	5-18	9-15	9-15	9-15
Height[a] (cm)		118.5-162.5	113.4-163.1		NA	NA
Weight[a] (kg)		20.4-48.2	19.5-51.5		NA	NA

a. Expressed as range

b. Whiting, Colleaux, & Bacchetto (1995)

c. Shatenstein and Ghadirian (1996)

d. Crocker study reported by Crocker et al. (1997) (two studies reported)

e. NA=Not available

The total number of children in our study is less than previous studies. All studies had higher female children's participation; in our study it was 52%. Table 5.1 summarizes numbers, age, height, and weight in the studies by Whiting et al. (1995), Shatenstein and Ghadirian (1996), and Crocker et al. (1997). The age, height, and weights of male and female children in the current study are comparable to the previous studies. The male and female mean age, height, weight, TSF and head circumferences in current study are not significantly different (Table 4.1). Therefore, it could be assumed that both male and female groups are similar to each other. Any difference in dietary intakes, physical activity and energy balance could be attributed to the children's sex and physiological differences.

5.2. Evaluation of dietary intakes

Table 5.2. summarizes macronutrient intakes of this study and previous studies (Shatenstein & Ghadirian, 1996; Whiting et al., 1995). The total energy and fat intakes were low in the current study. However, caution would be warranted before generalizing. Methodological differences in obtaining dietary intakes between this study and the other studies would have played a significant role in the differences in energy and fat intakes. The Shatenstein & Ghadirian, (1996) study used seven-day food records to assess the usual dietary intakes, and the Whiting, Colleaux, & Bacchetto (1995) study used up to six 24-hour recalls. The current study used three 24-hour dietary recalls and generally it is recognized that 24 hour recalls give lower estimates of energy intake than other dietary estimated method (Gibson, 1990). The level of energy intake is dependent on age, body weight, and height. Sixty percent of the current study group ranged from 6 to 10 years. This would have reduced the mean energy intakes as requirement is dependent on age. Forty percent of the current study group were underreporters, and the underreporters' energy intake is significantly lower than the normal reporters (Table 4.10). These factors would have had an impact on reducing the mean energy intake.

Table 5.2. Macronutrient intakes in published studies and the current study[a]

Variable		Current study		Whiting study[b]		Shatenstein and Ghadirian study[c]	
		Male	Female	Male	Female	Male	Female
Energy (kcal):	Range	1050-2549	885-2157	1752-2311	1569-1688	1667-2486	1664-2033
	Mean ±SD	1612 ± 371	1338 ± 289	NA	NA	NA	NA
Protein (g):	Range	37.1- 85.3	29.8-80.9	69.5-87.5	58.0-64.4	61-103	66-81
	Mean ±SD	59.6 ± 14.0	53.2 ± 12.1	NA	NA	NA	NA
Carbohydrate (g) :	Range	154.8-418.7	125.5-339.7	225-289	203-215	211-293	217-243
	Mean ±SD	223.4 ± 60.8	190.7 ± 51.1	NA	NA	NA	NA
Total Fat (g) :	Range	18.1-80.2	23.0-74.2	67.0-94.3	61.7-64.7	60-90	56-78
	Mean ±SD	55.8 ± 17.7	42.5 ± 11.5	NA	NA	NA	NA

a. Expressed as range, mean, and standard deviations

b. Whiting, Colleaux, & Bacchetto (1995)

c. Shatenstein and Ghadirian (1996)

The percentages of energy from carbohydrate, fat and protein were similar to the previous reported values except female fat intakes (The percentages of energy from carbohydrate, fat and protein were given in Table 4.2). However, the carbohydrate, protein, and fibre intakes were comparable to the intakes by children in other two studies (Shatenstein & Ghadirian, 1996; Whiting et al., 1995).

Vitamin, mineral and other supplement (e.g., herbal) intakes are becoming more prevalent, and have direct effect on daily micronutrient intakes. Whiting et al (1995) reported that 36% of children used a supplement at least once during a one year period. The National Health Interview Survey of United States reported that 36% of children under the age of 18 used supplements (Kovar, 1985). Three children (6%) in this study group reported having taken multivitamins occasionally at the times when they had infections, and no one was regularly taken multivitamins or any other supplements. This percentage is lower than what has been previously reported.

The mean micronutrient intakes of previous studies are given in Table 5.3. In the current study the most significant increase of intake was folate compared to the previous studies (Shatenstein & Ghadirian, 1996; Whiting et al., 1995). The mean level of folate intake was higher than previously reported intake levels for both males and females (Whiting, Colleaux, & Bacchetto, 1995). The Nutritionist IV data base consist of United States folate fortification values and this increased folate intake could have been a direct result of use of American data base. However similar levels of folate intakes for the current study group can be assumed because of fortification of grain products in Canada (Canada, 1997).

Mean micronutrient intakes of a group can overestimate or underestimate the extent of dietary adequacy of individuals within a group. Use of EARs and RNIs ascertain the actual number of children not reaching the set goals of micronutrients. The prevalence of children below EAR for iron was 2% (only 1 female) (Table 4.6). Cereals and breads are the primary sources of iron among children (Evers & Hooper, 1995). In a

study to determine iron intakes, almost one-quarter of daily iron intakes came from cereals (23.6%) and from breads (19.8%) (Leeman & Evers, 1997). Although the grain product servings in the current study by both males and females were similar and were slightly lower than the Canada's Food Guide recommended servings per day, did not have effect on iron inadequacies.

A large number of children did not reach EAR and AI goals for vitamin E and D. The reported energy and fat intakes were low in the current study. Also there was a significant number of underreporters in the current study. Underreporting can lead to the underreporting of other nutrients (Mertz, Tsui, & Judd, 1991). Reduced fat intake has a direct effect on reducing vitamin E intakes (Stephen & Deneer, 1990). For other fat soluble vitamins such as vitamin A and D, low level of fat intake might not have played a significant role. The number of servings of milk and vegetable products were below the recommended servings and reduced the intakes of vitamin A and vitamin D. The AI value for vitamin D is set at a higher level and could be a contributory factor for higher percentage of vitamin D inadequacies. For vitamin E particularly, the deficiencies in Nutritionist IV program is another significant factor (Dzioba, 1998). The Nutritionist IV contains data from the United States Department of Agriculture Hand Book No.8, Composition of Foods, Raw, Processed, Prepared which does not provide comprehensively the values for vitamin E for all foods.

Calcium was the common inadequate nutrient in children's diets in previous studies (Canada, 1973; Shatenstein & Ghadirian, 1996; Whiting, Colleaux, & Bacchetto, 1995). Also, Evers (1995) showed that mean intakes of vitamin A and calcium were below the RNI for children aged 7 to 9 years living in economically disadvantaged communities in Ontario (Evers & Hooper, 1995). In our study 45 % of males and 77% of females did not reach the AI goal for calcium. The higher AI value set for calcium increases the percentages of inadequacy of calcium. Underreporting of energy also would have an impact in reducing the value of Ca intakes. Whiting, Colleaux, & Bacchetto (1995) suggested that inadequacies of calcium and vitamin A intakes in children were due to insufficient intakes of vegetables and fruits or milk products which

Table 5.3. Micronutrient intakes in published studies and the current study[a]

Variable		Current study		Whiting study[b]		Shatenstein and Ghadirian study[c]	
		Male	Female	Male	Female	Male	Female
Calcium (mg) :	Range	420-1692	200-1918	1045-1299	903-1055	857-1114	938-1051
	Mean ± SD	872 ± 309	782 ± 362				
Iron (mg) :	Range	7.6-20.2	6.1-27.8	12.4-15.8	10.1-10.6	9.4-18.3	9.7-13.1
	Mean ± SD	12.5 ± 4.2	11.0 ± 4.3				
Thiamin (mg) :	Range	0.69-3.39	0.55-1.86	1.4-1.7	1.2-1.3	1.2-1.9	1.2-1.4
	Mean ± SD	1.47 ± 0.62	1.23 ± 0.34				
Riboflavin (mg) :	Range	0.90-2.24	0.60-2.47	1.7-2.2	1.5-1.7	1.8-2.5	1.9-2.4
	Mean ± SD	1.54 ± 0.34	1.40 ± 0.41				
Niacin[d] (NE) :	Range	8.8-23.8	1.1-33.8	NA	NA	12.9-21.9	14.6-17.3
	Mean ± SD	14.1 ± 4.3	13.0 ± 6.4				

a. Expressed as range, mean, and standard deviations

b. Whiting, Colleaux, & Bacchetto (1995)

c. Shatenstein and Ghadirian (1996)

d. Values in Niacin Equivalents

e. e. Reported values were converted to Retinol Equivalents, assuming IRE = 5IU

Table 5.3. Continued

Variable		Current study		Whiting study[b]		Shatenstein and Ghadirian study[c]	
		Male	Female	Male	Female	Male	Female
Folate (μg) :	Range	87-491	90-392	163-205	139-172	NA	NA
	Mean ± SD	231 ± 109	188 ± 65				
Vitamin C (mg) :	Range	24-292	23-268	95-110	84-118	132-177	119-171
	Mean ± SD	102 ± 66	88 ± 70				
Vitamin A[e] (RE) :	Range	243-3380	229-3192	832-1191	892-1080	1077-1316	891-1297
	Mean ± SD	1180 ± 888	849 ± 661				

a. Expressed as range, mean, and standard deviations

b. Whiting, Colleaux, & Bacchetto, 1995

c. Shatenstein and Ghadirian, 1996

d. Values in Niacin Equivalents

e. Reported values were converted to Retinol Equivalents, assuming IRE = 5IU

we also observed in the older(10 to 15 years) children group. None of the nutrient intakes exceeded the tolerable upper limits (UL) for those analyzed nutrients. When nutrient intakes exceed UL, the risk of toxic effect from those nutrients is increased. The intakes above the UL can occur from intakes of foods that are fortified with those nutrients, or by taking supplements. The supplement intakes were not included for nutrient intakes since the detail information on supplement intakes by children were not collected in the current study. Therefore, it is difficult to conclude that micronutrient intakes levels did exceed the ULs.

5.3. Evaluation of physical activity

Physical activity is multidimensional and there is no "gold standard" to assess physical activity. Physical activity measuring techniques assess different aspects of physical activity. For this study, PAQ-C, Caltrac, and activity diary were used. The PAQ-C was used due to its validity, convenience and cost-efficiency to assess children's general level of physical activity. The PAQ-C cannot be used to estimate calorie expenditures (Crocker et al., 1997). Caltrac was used to assess physical activity related to energy expenditure. The activity diary was used to determine activity related energy expenditure as another measure.

The studies (Crocker et al., 1997; Johnson et al., 1998; Kowalski et al., 1997; Sallis et al., 1990) conducted to assess children's physical activity used different instruments. Table 5.4 is a summary of studies which were using PAQ-C, activity diary, and Caltrac or instruments similar to activity diary (Crocker et al., 1997; Johnson et al., 1998). The levels of physical activity of the current study group were similar to the previously reported values.

The level of physical activity between male and female children was not significantly different ($p<0.05$) as assessed by PAQ-C, Caltrac and the activity diary. It has been found that boys were more active than girls (CPFRI, 1998, Pate et al., 1994; Sallis, 1993). This difference is due to that boys' activities were more intensive of

chosen activities and spent more time on activities (CFLRI, 1998). In two studies, Kowalski et al., (1997) reported that in Study I males were more active than females. However, Study II reported no difference in male and female activity levels. Kowalski et al., (1997) used six to seven additional physical activity instruments in two studies other than PAQ-C. Our results showed that male and female children had similar levels of physical activity consistent with the study II by Kowalski et al. (1997).

The activity diary-energy expenditure of this study was similar to the other studies (Goran, Hunter, & Johnson, 1997; Johnson et al., 1998) that estimated activity related energy expenditures. Activity diary-based energy expenditure is another measure to estimate the physical activity related activity expenditures other than Caltrac. The advantages of activity diaries over the other PAQ-C and Caltrac were that it consumed less time, was less complicated, and children were more motivated to complete their own diaries. However, one limitation of the activity diary is that energy cost is calculated in relation to the activity-related categorical value. This value is an approximate median of the energy expended in when engaged activities of that category. Although the categorical value for the dominant activity of the given period is based on adult values, it can be used for children's energy expenditure based on their age, sex and weight (Torun, 1983, WHO, 1985).

Children spend only a small fraction of their active time in high-intensity activities (Bailey et al., 1995; Thorland & Gilliam, 1981). Caltrac can estimate daily energy expenditure which includes the energy costs of those activities. Mean Caltrac daily expenditure values showed that there was no significant difference in the levels for male and female children. Therefore, it can be concluded that the male and female level of activities are same according to PAQ-C, Caltrac and the activity diaries.

Ideally, two physical activity instruments should have a very good correlations if they are employed to assess the physical activity of the same individual. However, the multidimensional nature of physical activity and the absence of an ideal instrument, poor

Table 5.4. Comparison of activity and basal energy expenditures to the other studies[a]

Variable	Current study		Other studies[b]	
	Male	Female	Male	Female
PAQ-C (1-5 scale)	3.03 ± 0.68	2.79 ± 0.45	3.44 ± 0.68	2.96 ± 0.69
Physical activity energy expenditure[c] (kcal/day)	570 ±235	581 ±258	598 ± 353	313 ± 275
Caltrac energy expenditures (kcal/day)	1199 ± 611	1284 ± 795	1006 ± 371	895 ± 401

a. Expressed as mean, and standard deviations

b. Other studies include studies by Crocker et al. (1997), Johnson and Goran (1998)

c. Physical activity energy expenditure was determined by activity diaries in the current study and in Johnson study by the difference between total energy expenditure and postprandial resting energy expenditure

or no correlations between instruments is not unusual. That is, when two different instruments are applied to the same group of people, at the same time, instruments measure different phenomena of physical activity (Baranowski, 1988). For example, the activity index derived by the PAQ-C is a reflection of general level of weekly activities and is not dependent on factors such as intensity or efficiency. Activity energy expenditure by Caltrac is a reflection of time and intensity of physical activities. Therefore, physical activity behavior by questionnaire is not synonymous with physical activity related energy expenditures (Baranowski, 1988).

In the current study, Caltrac and Activity Diary had a significant positive correlation ($r = 0.313$). Caltrac and activity diaries both assess energy expenditure. It has been reported that there is a moderate to low correlation between Caltrac and one day activity recall (Sallis et al., 1990). The PAQ-C did not have a significant correlation with activity diary based energy expenditure or Caltrac. This could have been due to these instruments estimating different aspects of physical activity, hence gives no correlation.

Compliance was an issue in children's physical activity studies when using Caltrac. A study using Tritrac (a similar type of activity counter) reported that 43% of children did not wear it during their active periods (Holowachuk, 1998) In the current study for seven (14%) children the researcher (PT) had to reset the Caltrac before they started wearing. Four children (8%) did not wear the Caltrac. This is because of discomforts, interference with activity and peers in their schools. For the activity diary, eight children (16%) started to enter their activities from the 2nd day. Three had missing data for at least one time interval and therefore were excluded from analysis. One child (2%) did not complete PAQ-C. These factors would have impacted on correlation values of three instruments.

In the current study Caltrac energy expenditure is higher than the activity diary based energy expenditures. Johnson et al. (1998) reported that calorie expenditure using

Caltrac was found to be significantly higher in comparison with measured activity energy expenditure in free living children. This is because of Caltrac captures spontaneous physical activities, so part of the high energy expenditures reflected in Caltrac could be due to children's spontaneous physical activities. Although Caltrac able to determine physical activity including spontaneous physical activities, it requires greater effort from the researcher and parents for compliance.

5.4. Energy intake, expenditure, and balance

Table 4.9 gives energy intakes, energy expenditures for male and female children. Energy balance is the difference between energy intake and expenditure. Energy balance was negative in both males and females, and there was a significant difference ($p<0.05$) in energy balance between males and females, with a greater negative balance in females. The energy intake of this study group was lower than the what has been previously reported (Shatenstein & Ghadirian, 1996; Whiting et al., 1995). Also, female total fat intake and percentage of energy from fat was lower compared to males.

The energy expenditure by physical activity is the most variable component in daily energy expenditure, and therefore plays a significant role in the regulation of energy balance (Goran et al., 1999). The combined energy expenditure from basal metabolic rate and physical activity exceeded the level of energy intakes resulting in an apparent negative energy balance in males and females. However, energy loss due to thermic effects of foods, sweat and other forms of loss of energy from body was not assessed in this study. This is a limitation to determine the actual total energy expenditure and to determine the true magnitude of the apparent negative energy balance.

5.5. Evaluation of dietary intakes, physical activity and underreporting

Twenty children (40%) were underreporters: eight males and twelve females. There was no association between sex of children and underreporting. The distribution of EI/BMR with BMI is given Figure 4.3. The characteristics of underreporters and normal reporters are given in Table 4.10. The underreporters' mean BMI and age were significantly higher than the normal reporters. In the current study children's BMI was negatively correlated with the degree underreporting (Figure 4.3). It has been shown that the BMI of underreporters is negatively correlated to reported dietary intakes (Johansson,1998). Carter, (1999) reported that children with higher ponderal indices were underreporters and were related with lower physical activity than normal reporters. In the current study, the levels of energy intake and physical activity were lower than the normal reporters. Underreporters' ages were significantly higher than normal reporters. It was found that female's age was positively related with underreporting (Carter, 1999). However, this relationship was not observed in females or males in the current study. Also it was found that both male and female underreporters spend less energy on physical activity compared to the normal reporters. Therefore it could be assumed that there is a tendence that underreporters have a potential to become obese given the level of physical activity and underreporting in their energy intakes.

5.6. Limitations

The total number of children in this study was 50, which was less than the other nutrition or physical activity studies performed in Canada. This small sample size was due to cost and subject burden since this study had both diet and physical activity. This is a limitation in generalizing the results of the current study to a larger children's population. For this study the children's parents were university employees, students and friends of university employees or students, and all children attended schools in Saskatoon. From the parents' level of income and socio-economic status, it could be assumed children were in the middle or upper class categories. Parents' income and SES have a significant impact on children's choice and access to a nutritious diet and healthy physical activities. Khoury et al (1981) have observed positive correlations between parental SES and nutrient intakes, and found American school children with higher SES tend to eat closer to dietary recommendations than the lower classes (Khoury,1981). In a study of children living in economically disadvantaged communities in Ontario, those children had limited opportunities and access for physical activities (Evers & Hooper, 1995). These children's anthropometric data showed growth was adequate, but they had excess body fat. Non representation of children from lower socioeconomic and income category parents could be a limitation, and future studies on children from lower SES groups is needed to generalize the findings of the current study for a larger population.

The age and maturity level of the children are significant factors in determining the nutrient and physical activity requirements. The confounding effects by these factors were not determined and is another limitation.

All dietary intakes were analyzed using the Nutritionist IV data base. As it was discussed Nutritionist IV had deficiencies in analyzing vitamin E. This database was developed in 1994, and since then there have been many of new food items available in the market. Use of 1994 data base for year 2000 food items could be a limitation for the

accurate estimation of nutrient intakes.

Three physical activity instruments for younger children increased subject burden especially Catrac. This was evident from the level of compliance on Caltrac. Also, it added an extra responsibility for parents to make sure their children fully participate in this study.

5.7. Conclusions

Energy intakes of both male and female children of the current study were less than previously reported levels. This could be a continuation of decline in average energy intake that has been observed since 1960s in United States and particularly true when comparing with the results of the Canadian studies conducted in mid 1990s. The higher number of inadequacies in intakes of calcium, vitamin, A and vitamin D were observed in this study. All nutrition studies on children conducted in Canada since 1973 reported inadequacies of calcium and vitamin D where prevalence of inadequacies. One reason given for these nutrient inadequacies was that the intake of vegetables and fruits and milk products was below the recommended number of servings of 1992 Canada Food Guide to Healthy Eating (Whiting et al., 1995). The level of intakes in this study of the same food types were below the recommended level and would have mostly affected children in age 10 to 15 years group, particularly for girls. However, folate intakes were higher in both males and females of the current study group. This could be a result of use of Nutritionist IV data base which is mainly derived from American diets.

The children of the current study group are active in terms of benefitting from physical activities. This was evident from their daily physical activity energy expenditures and the apparent mean energy balance. Also, both male and female children are equally active according to the all three physical activity instruments used for this study.

The results of the current study indicated that both male and female children had an apparent negative energy balance. The significant number of underreporters in the current study would have played a major role in reducing the energy intakes and causing apparent negative energy balance. It could be concluded that the children's dietary intakes and physical activity were adequate despite the inadequacies observed in vitamin D, vitamin A, and vitamin E.

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LIST OF APPENDICES

Appendix A

Study consent form

Nutrition and Physical Activity

Consent Form

I agree to allow my child, _____, to participate in the nutrition and physical activity study.

I also understand the following:

1. I have received explanations about the nature of the study, its purpose, procedures and possible benefits.

2. My child is a volunteer and can withdraw at anytime from the study without any fear or penalty. Withdrawl from the study will not affect the health care of your child.

3. I will be told of any changes in the study that may effect my child's participation in the study.

4. There is no risk of physical and psychological harm.

5. As part of this study my child may be required to wear a motion sensor for a period of time (to be removed a night and during bathing/swimming). My child will not be responsible for any damage to this sensor.

6. All precautions will be taken to protect your child's anonymity. The individual data your child provides will remain private from sources outside of the study. Group data will be presented whenever possible. However, where it is necessary to show individual results, these will be coded so as to protect the identity of your child. The findings of the work will be submitted to a journal for publication and form part of a graduate thesis.

7. I will receive a summary of the project upon request, following the completion of the project.

8. If I have any questions with regard to the research project, I can contact any of the researchers listed below:

Thava Pushparajah	Home: 374-4916	Work: 966-5831
Dr. Susan Whiting		Work: 966-5837
Dr. Gordon Zello		Work: (514) 398-7614

College of Pharmacy and Nutrition, University of Saskatchewan
110 Science Place, Saskatoon SK S7N 5C9 Telephone: Pharmacy (306) 966-6327; Nutrition (306) 966-5824 Facsimile: (306) 966-6377
Web Site "http://www.usask.ca/nutpharm/"

I hereby acknowledge that the content of the consent form has been explained to me and that I have received a copy of the consent forms for my own records.

Signature of Parent/Guardian	Date
Signature of Child	Date
Signature of Researcher	Date

Appendix B

Demographics, anthropometry, and other information questionnaire

Subject # _____

Demographic Data

Sex: M
F

Date of Birth: _____

Height (cm): _____

Weight (kg): _____

Triceps skinfolds (mm): _____ _____ _____

Head circumference(cm): _____

1. Are your child's food habits influenced by your religious, cultural or ethnic background?
   ❒ No
   ❒ Yes (Please describe)

   _____

   _____

2. Do your child has been dieting recently?

   _____

3. Have your child gained significant weight recently?

   _____

4. Does your child have any food allergies or aversions?
   ❒ No
   ❒ Yes (Please describe)

   _____

5. Does your child take any special foods regularly?

_____

6. Does your child take vitamins, minerals, other supplements(e.g., herbal)?

If yes, what?, how much?, how often?

_____

7. How would you describe your child's appetite?

_____

8. Most recent infection(what? and when?):

_____

9. Other medical conditions(not related to FAS/ADHD)

_____

10. Was this a usual day? Eating, activity etc.

_____

11. Does your child take any medications? What? When? How much?

_____

Appendix C

Twenty-four hour recall form

NUTRITION SURVEY Date of recall ___/___/___

24-HOUR DIETARY RECALL FORM Subject name: _____

Time	Rest/Cafe	Meal/Snack	Home prep	Food description	Portion	Model	Thick.

Time	Rest/Cafe	Meal/Snack	Home prep	Food description	Portion	Model	Thick.

Restaurant/Cafeteria
C=cafeteria
F=fast food restaurant
R=restaurant (table service)
T=take-out outlets
V=vending machines, snack bars

Meals and Snacks
BK=breakfast
L=lunch
D=dinner
BC=brunch
O=other meal occurrence
S=snack

Home preparation
H=home prepared foods such as soups, salads, any composite dish, home made desserts

Have you prepared most of these meals? Yes___ No____
Was this a usual day? Yes___ No___

Appendix D

Twenty-four hour dietary recall script

24 Hour Recall SCRIPT

STEP 1: Foods and Beverages consumed

1. **Start with midnight** - ask "did your child have anything to eat or drink after midnight the night before last night?"

2. **Move to morning** - ask "what was the first thing your child had to eat or drink after you got up?"
   -ask "what time was that?"
   -ask about condiments added (eg. creamer to coffee, butter on toast, etc.)

3. **Morning-lunch** - ask when was the next time your child had something to eat? What did you have?"
   -ask about condiments
   -may help to ask about events during the day (eg. going to school, a friend's house, walking) to recall info about foods eaten.

4. **Lunch** - do not assume the child eats lunch, first ask when was the next time he/she had something to eat.

5. **Afternoon** - again, referring to schedule of day may help to recall food items eg. "did your child have a coffee break in the afternoon. Did you eat or drink anything during that time?"

6. **Supper** - similar to lunch
   - ask if nibbled during preparation of supper

7. **Evening** - ask "when was the next time your child had something to eat or drink?"

**spacing* - think ahead, leave spaces for items like coffee where a condiment may have been forgotten

***record amounts of food eaten if they are mentioned by the person, but do not interrupt the person's train of thought. Amounts can be recorded later in detail.

STEP 2: Details of Foods and Amounts

* begin asking detailed description of items eaten
* *labels* are useful in recording the detail required (eg. Salad dressing types)
  -record brand names
  -if unfamiliar with product, record the name of the food, how it was prepared, how it was cooked, and what ingredients were added
* *recipes* are **not needed for home-made baked goods** (such as muffins, cookies, and pies) eaten in usual serving sizes, **or simple dishes** (such as soups, sauces, etc.) The type of fat or oil, the kind of fluid used, and any important non-basic ingredients (nuts, raisins, etc.) in these foods should be recorded on the 24-hour recall form.
  -use judgement on stews and chilis, etc. if should obtain recipe or not. (ie. is recipe atypical?)

1. FATS

- record **brand name and type of fat** (eg. canola) - some companies produce two products, two different fats used
- margarine - also need - soft or hard
  - regular or light
- gravies and sauces - record type of fat used
  - if meat drippings used, ask if any fat was removed before thickening-dressings and mayonnaise- regular, light, ultra low-fat, etc.
  - type of fat difficult - record brand name
  - if made from package - record type of fat used
- if fat source unknown (as in restaurant) - record '*fat source unknown*'

2. MEATS

- **kind of meat** - record *type and cut* of meat (diagrams of cuts will help)
- **method of cooking** (eg. roasted, pan-fried, stewed, etc.)
  - record any pre-treatment (eg. marination, soaking)
  - record **ingredients added,** during cooking and served with the meat,

separately

- record fats added during cooking (type) - do not need amount if not served with/on the meat - if eaten with meat as drippings, need amount
- record if **lean only or lean + fat** (L + F) was eaten
- record amount actually eaten - try to get portion eaten **not including bone**
- if only bone-in size can be determined, record *bone-in*
- if weights are given, specify **raw weight** (unless the person weighed the food after cooking, only raw weight can be known) *meat shrinks with cooking
- if ham, specify fresh or cured

2.1. Luncheon meats

- record **type** (brand name if possible) and whether sliced, packaged or processed, cold cuts, canned products, or pates
- **SLICE** - can be used if number of slices and weight of package is known
- otherwise - use portion-size models
- pates & flaked products - use tbsp or other approp. model
- SLIVER - used if slices thinner than 1/8 inch

3. FISH

- record species, whether canned, fresh or frozen, cooking method, and size of amount eaten
- cooking method - type of fat used (record quantity only if served with fish)
- breaded, battered, fried (deep-fried or pan-fried)
- canned - eg. Tuna - white or light; in oil or water (was oil drained)
- exclude all unedible parts (if included in size, clearly indicate on form)
- UNIT - can be used for some seafoods eg. Shrimp, scallops, mussels
- similar to meats - record RAW WEIGHT if offered and indicate as so

4. POULTRY

- record species, whether fresh, frozen, or canned, the cooking method, and information about ingredients added during cooking (breading, batter, etc.)
- cooking method- type of fat used
  - roasted, stewed, pan-fried (deep-fried or pan-fried)
- record as **white or dark** (W or D or W+D)
- record whether **skin** was eaten or not (meat only -M- or meat and skin - M+S-)
- **UNIT** - can be used for parts eaten eg, drumstick, thigh, wing, breast (*leg* includes drumstick and thigh)
- try to indicate small, medium, large
- balls can be used for chicken nuggets or other roundish pieces, fingers in dimensions, and diced or chopped poultry as volumes

5. MILK PRODUCTS

- describe **milk** as whole, 2%, 1%, skim (% M.F.), or chocolate (2% or 1%-light);
- also record if calcium-enriched
- buttermilk;
- cereal cream, **half and half**, and **table cream** (aka coffee cream - 15-20% B.F.);
- **coffee whitener** as powered, liquid, or frozen
- **whipping cream** (whipped or unwhipped is 32 to 38% B.F.);

for non-dairy whipped topping record brand name and type (regular, light, etc)

- for these items record quantity as whipped or unwhipped
- **evaporated** whole, 2%, or skim milk (diluted or undiluted)
- **condensed** milk (regular, light - record % fat)
- yogurt - plain, fruit on bottom, stirred or frozen + % fat

CHEESE:

- describe by type (Edam, Swiss, Cottage, Cream, etc.)
- use dimensions or volumes (eg. shredded)
- record % fat if known - as B.F. or M..F. or if produced from skim or partially skim milk
- processed cheese - record as thick or thin or indicate # of slices from package of specified weight

6. GRAIN PRODUCTS

a. BREADS and ROLLS

- record type of bread and number of slices - whole wheat (100%, 60%) or white
- record if toasted
- if non-sliced loaf - use models, record type (eg. pumpernickel)
- buns - use models to record size
- if homemade - record type of fat and milk (if used)
- record any non-basic ingredients, eg. nuts, raisins
- if eaten without spread, record as 'no spread' or 'dry'
- hamburger and hot dog buns, and english muffins, can be recorded as 1UNIT

b. BAKED GOODS

- type of product, iced vs. not iced, homemade vs. commercial
- if **homemade** - record type of fat and milk (if used)
  - record if nuts, fruit, etc added
- if **commercial** - record brand name and description
- biscuits - 'tea' vs. 'cookie type'
- **muffins** - use circle surface area models + thickness indicators
  - indicate whether 'mushroom-shaped' or 'rounded'
- **donut** - cake vs. yeast, iced vs. non-, type
- **pie** - *thickness* measured at point of wedge (not outer crust)

c. CEREALS, PASTA, AND RICE

- record brand name, and quantity using models or as pre-packaged individual sizes
- don't forget milk on cereal! (~ ½ cup minimal, ¾ cup lots, and 1 cup allows dry cereal to float)
- pasta - enriched vs non enriched (EN or NON-EN), homemade vs. commercial
- give details about mixed dishes made with pasta
- if homemade and a 'main dish' get recipe, if commercial - brand name

7. VEGETABLES

- descriptive name
- fresh, frozen, or canned
- record method of cooking (baked, boiled, stir-fried, microwaved)
- also if peeled and/or diced, etc. before cooking
- use models or units, where appropriate
- mixed dishes - try to list ingredients in descending order of quantity
- record ingredients added when cooking
- record ingredients added when served
- record part and amount eaten (eg potato with/without skin)

8. FRUITS

- descriptive name
- fresh, dried, canned, frozen
- peeled vs. non-peeled
- **canned fruit** - record type of liquid canned in (light syrup, heavy syrup, own juice)
- **cooked fruits** - sweetened vs unsweetened
- record ingredients added when cooking
- record ingredients added when served
- record part and amount eaten (eg. apple, raw, with skin)

9. BEVERAGES AND SOUPS

- record volume
- if served with a lot of ice, subtract ice volume before recording
- pop - size of container
- **juice** - fresh, frozen, canned or bottled, sweetened or unsweetened, with or without added vitamin C (eg. apple juice, grape juice or nectars)
- diluted or undiluted
- non-juices -'drink', 'punch', or "from powder" -indicate <u>mixed according to direction</u>
- **coffee** - brewed, instant, decaffeinated, or coffee substitute (eg Postum)
- mineral water- should be recorded
- home-made cream **soups**, fish chowders or commercial canned or dehydrated soups-
- record diluent (water, kind of milk, cream or other) liquid used
- record **artificial sweeteners** used

10. SNACKS AND CRACKERS

- record **brand name and type**
- record quantity by UNIT, volume or by weight (when known)

11. FAST FOODS

- record hamburgers, hotdogs, french fries, submarines, and other fast foods with as much detail as possible (eg. 2 oz hamburger, 12" hot dog, etc.)
- indicate brand name
- not necessary to record bun separately (note if bun not eaten)
- **pizza** - record thick or thin crust
- vegetable and/or meat (state type) and/or cheese toppings
- use **thickness** indicator (measure from point of wedge)
- record **diameter** of pizza, franchise, and total number of slices for pizza
- **homemade** - record diameter, total number of servings, and thickness

12. SWEETS (candies, chocolate bars, pudding)

- record brand name
- if weight of choc bars unknown -price will help identify size
- lifesavers, hard candy, chewing gum, gum drops or jelly beans - record UNIT or volume
- puddings - indicate home-made or mix and if made with milk, type of milk used

13. MIXED DISHES

- if **homemade** - record recipe
- if unknown ingredients + amounts - record full description as possible
- record brand name if applicable
- mixture w/ limited ingredients can be recorded on 24-hour recall

Appendix E

Physical activity questionnaire for older children

Physical Activity Questionnaire

Subject:.....
Age: .....
Sex: .....

We are trying to find out about your child's physical activity levels that he/she has done in the last 7 days(in the last week). This includes sports or dance that make child sweat or make child feel tired, or games that make he/she huff and puff, like tag, skipping, running, climbing and others.

Remember:

A. There are no right and wrong answers-this is not a test.
B. Please answer all the questions as honestly and accurately as you can- this is very important.

---

1. PHYSICAL ACTIVITY IN CHILD'S SPARE TIME
Has your child done any of the following activities I the past 7 days(last week)? If yes, how many times?

** Tick Only One Circle Per Row**

	No	1-2	3-4	5-6	7times or more
Skipping	❑	❑	❑	❑	❑
Four Square	❑	❑	❑	❑	❑
Creative Playground	❑	❑	❑	❑	❑
Tag	❑	❑	❑	❑	❑
Walking for exercise	❑	❑	❑	❑	❑
Bicycling	❑	❑	❑	❑	❑
Jogging or running	❑	❑	❑	❑	❑
Aerobics	❑	❑	❑	❑	❑
Swimming	❑	❑	❑	❑	❑
Baseball, softball	❑	❑	❑	❑	❑
Dance	❑	❑	❑	❑	❑
Football	❑	❑	❑	❑	❑
Badminton	❑	❑	❑	❑	❑
Skateboarding	❑	❑	❑	❑	❑
Soccer	❑	❑	❑	❑	❑
Street hockey	❑	❑	❑	❑	❑
Volleyball	❑	❑	❑	❑	❑
Floor hockey	❑	❑	❑	❑	❑
Basketball	❑	❑	❑	❑	❑
Ice skating	❑	❑	❑	❑	❑
Cross-country skiing	❑	❑	❑	❑	❑
Ice hockey/Ringette	❑	❑	❑	❑	❑

Other: ❑ ❑ ❑ ❑ ❑

.....

.....

2. In the last 7 days, during your physical education(PE) classes, how often were your child very active(playing hard, running, jumping, throwing)?

He/she does not do PE	❑
Hardly ever	❑
Sometimes	❑
Quite often	❑
Always	❑

3. In the last 7days what did your child do most of the time at RECESS?

Sat down(talking, reading, doing school work)	❑
Stood around or walked around	❑ Check
Ran around or walked around	❑ one
Ran around and played quite a bit	❑ only
Ran and played hard most of the time	❑

4. In the last 7days, what did your child normally do AT LUNCH (besides eating lunch)?

Sat down(talking, reading, doing school work)	❑
Stood around or walked around	❑ Check
Ran or played a little bit	❑ one
Ran around and played quite a bit	❑ only
Ran and played hard most of the time	❑

5. In the last 7 days, on how many days RIGHT AFTER SCHOOL, did your child do sports, danced or played games in which your child was very active?

None	
1 time last week	❑
2 or 3 times last week	❑ Check
4 times last week	❑ one
5 times last week	❑ only

6. In the last 7 days, on how many EVENINGS did your child do sports, danced, or played games in which he/she was very active

None	❑
1 times last week	❑ Check
2 or 3 times last week	❑ one
4 times last week	❑ only
6-7 times last	❑

7. ON THE LAST WEEKEND, how many times did your child do sports, danced, or

played games in which he/she was very active?

None . . . . . ❒
1 time . . . . . ❒ Check
2-3 times . . . . . ❒ one
4-5 times . . . . . ❒ only
6 or more times . . . . . ❒

8. Which ONE of the following describes your child best fir the last 7 days?

Read ALL FIVE statements before deciding on the one answer that describes you

A) All or most of my child's free time was spent doing things that involve little physical effort(e.g., watching TV, doing home work, playing computer games, Nintendo) ❒

B) Some times(1-2 times last week did physical things in his/her free time(e.g., played sports, went running, swimming, bike riding, did aerobics) ❒

C) Often did physical things in his/her free time ❒

D) Quite often (5-6 times last week) did physical things in his/her free times ❒

E) Very often (7 or more times last week) did physical things in his/her free time ❒

9. How many hours per day did your child watch television or play Nintendo last week? (each show is usually half hour or 30 minutes).

A) Watched less than 1 hour or have no TV ❒
B) Watched more than 1 hour but less than 2 ❒
C) Watched more than 2 hours but less than 3 ❒
D) Watched more than 3 hours but less than 4 ❒
E) He/She watched more than 4 hours ❒

10. Was your child sick last week, or did anything prevent you from doing his/her normal physical activities?

Yes. . . . . ❒
No. . . . . ❒

If Yes, what prevented him/her?.....

11. Mark how often your child did physical activity (like playing sports, games, doing dance or any other physical activity) for each day last week

	None	Little Bit	Medium	Often	Very Often
A)Monday	❒	❒	❒	❒	❒
B)Tuesday	❒	❒	❒	❒	❒
C)Wednesday	❒	❒	❒	❒	❒
D)Thursday	❒	❒	❒	❒	❒
E)Friday	❑	❑	❑	❑	❑
F)Saturday	❑	❑	❑	❑	❑
G)Sunday	❑	❑	❑	❑	❑

Appendix F

Activity diary

ACTIVITY DIARY

Please enter the type of activity that your child mostly engaged in during those time periods.

Day 1

	Activity/Activities	Other
Early morning		
Late morning		
Noon		
Afternoon		
Evening, Night		

Day 2

	Activity/Activities	Other
Early morning		
Late morning		
Noon		
Afternoon		
Evening, Night		

Day 3

	Activity/Activities	Other
Early morning		
Late morning		
Noon		
Afternoon		
Evening, Night		

Appendix G

Example of nutritionist analysis information

Dietary Intake

test1
Age: 12 Male
Company: University of Saskatchewan
Date: April 27, 1999

Basic Components

		% of calories
Calories	2155 Kc	
Protein	71.41 Gm	13 %
Carbohydrate	304.80 Gm	57 %
Fat	69.94 Gm	29 %
Alcohol	.00 Gm	0 %

Code	Food Item	Intake	Amount	Day	Meal
#1245	CEREAL-RICE KRISPIES-KELLOGGS	3.50	FL OZ	Day 1	Breakfast
#51	MILK-2% FAT-LOWFAT-FLUID	2.50	FL OZ	Day 1	Breakfast
#9288	Jam-Strawberry-KRAFT	2.00	TSP	Day 1	Breakfast
#8702	BREAD-WHOLE WHEAT-COMM PREP-TOAST	2.00	SLICE	Day 1	Breakfast
#104	BUTTER-REGULAR	1.00	TBSP	Day 1	Breakfast
#14006	RICE-BASMATI-DRY-FANTASTIC FOODS	0.75	CUP	Day 1	Lunch
#1178	CURRY POWDER	1.00	TSP	Day 1	Lunch
#5796	POTATO-BOILED WITHOUT SKIN-FLESH	0.50	CUP	Day 1	Lunch
#18226	OIL-CANOLA/CORN BLEND-CRISCO-P & G	0.50	TSP	Day 1	Lunch
#211	CHICKEN-DRUMSTICK-WITH SKIN-FRIED/FL	2.00	ITEM	Day 1	Lunch
#1412	SODA-CREAM FLAVORED-CARBONATED	6.00	FL OZ	Day 1	Lunch
#361	BREAD-WHOLE WHEAT-FIRM-ENRICHED	2.00	SLICE	Day 1	Dinner
#161	BACON-PORK-BROILED/PAN-FRIED/ROASTE	3.00	SLICE	Day 1	Dinner
#22	CHEESE-AMERICAN-PASTEURIZED PROCESS	1.00	OUNCE	Day 1	Dinner
#627	LETTUCE-ICEBERG-RAW-LEAVES	2.00	PIECE	Day 1	Dinner
#1412	SODA-CREAM FLAVORED-CARBONATED	6.00	FL OZ	Day 1	Dinner
#16735	MUFFIN-CARROT	1.00	ITEM	Day 1	Morning
#17600	CANDY-REESES PEANUT BUTTER CUP-HERS	2.00	PIECE	Day 1	Afternoon

University of
Saskatchewan

test1

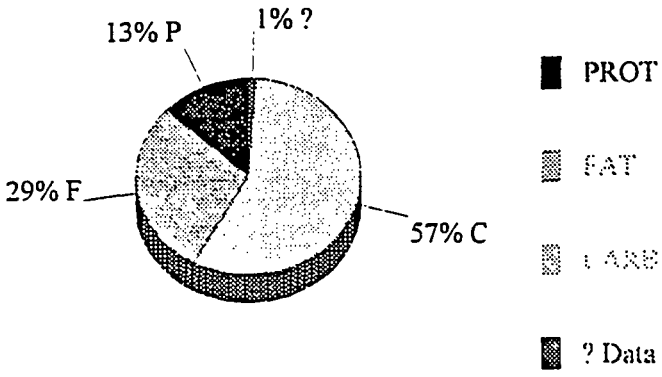
Goal Type: Custom Client Goals
Total Days: 1
Total Foods: 18
April 27, 1999

Nutrient	Daily Avg.	Goal	Goal %	Miss
Kilocalories (Kc)	2155	2182	98 %	(0)
Protein (Gm)	71.41	81.83	87 %	(0)
Carbohydrate (Gm)	304.8	327.3	93 %	(0)
Fat (Gm)	69.94	60.61	115 %	(0)
Cholesterol (mg)	189.4	None	- %	(0)
Saturated Fat (Gm)	27.48	12.12	226 %	(0)
Mono Fat (Gm)	25.4	24.24	104 %	(0)
Poly Fat (Gm)	12.65	24.24	52 %	(0)
Oleic Fat (Gm)	16.21	24.24	66 %	(4)
Linoleic Fat (Gm)	5.288	4.849	109 %	(3)
Linolenic Fat (Gm)	0.684	1.400	48 %	(4)
EPA-Omega 3 (Gm)	0.01	None	- %	(5)
DHA-Omega 3 (Gm)	0.04	None	- %	(5)
Sodium (mg)	2066	None	- %	(0)
Potassium (mg)	1488	None	- %	(2)
Iron (mg)	9.889	8.000	123 %	(0)
Calcium (mg)	576.4	900.0	64 %	(0)
Magnesium (mg)	212.7	130.0	163 %	(3)
Phosphorus (mg)	991.8	700.0	141 %	(3)
Zinc (mg)	8.406	9.000	93 %	(3)
Copper (mg)	0.882	None	- %	(3)
Manganese (mg)	3.236	None	- %	(4)
Selenium (mg)	0.044	None	- %	(8)
Fluoride (Ug)	253.7	None	- %	(10)
Chromium (mg)	0.089	None	- %	(14)
Iodine (Ug)	-	125.0	- %	(18)
Molybdenum (Ug)	5.883	None	- %	(14)
Vitamin A (RE)	597.5	800.0	74 %	(0)
Beta-Carotene (Ug)	25.96	None	- %	(6)
Vitamin E (mg)	2.891	8.000	36 %	(4)
A-Tocopherol (mg)	0.611	None	- %	(13)
Thiamin B1 (mg)	1.101	1.000	110 %	(3)
Riboflavin B2 (mg)	1.109	1.300	85 %	(3)
Niacin B3 (mg)	17.49	18.00	97 %	(3)
Pyridoxine B6 (mg)	1.24	None	- %	(3)
Folate (Ug)	171.5	120.0	142 %	(3)
Cobalamin B12 (Ug)	1.31	1.000	130 %	(1)
Pant. Acid (mg)	2.878	None	- %	(6)

Nutrient	Daily Avg.	Goal	Goal %	Miss
Biotin (Ug)	9.197	None	- %	(11)
Vitamin C (mg)	19.02	25.00	76 %	(0)
Vitamin D (Ug)	2.096	2.500	83 %	(8)
Vitamin K (Ug)	66.33	None	- %	(12)
Dietary Fiber (Gm)	15.36	None	- %	(0)
Soluble Fiber (Gm)	0.35	None	- %	(7)
Insol. Fiber (Gm)	1.515	None	- %	(7)
Crude Fiber (Gm)	2.908	None	- %	(2)
Sugar (Gm)	89.65	None	- %	(1)
Glucose (Gm)	2.416	None	- %	(6)
Galactose (Gm)	0	None	- %	(4)
Fructose (Gm)	2.989	None	- %	(6)
Sucrose (Gm)	0.925	None	- %	(7)
Lactose (Gm)	3.95	None	- %	(5)
Maltose (Gm)	0.5	None	- %	(9)
Tryptophan (mg)	668.1	None	- %	(5)
Threonine (mg)	2050	None	- %	(5)
Isoleucine (mg)	2540	None	- %	(5)
Leucine (mg)	4018	None	- %	(5)
Lysine (mg)	3901	None	- %	(5)
Methionine (mg)	1268	None	- %	(5)
Cystine (mg)	730.5	None	- %	(5)
Phenylalanine (mg)	2306	None	- %	(5)
Tyrosine (mg)	1896	None	- %	(5)
Valine (mg)	2730	None	- %	(5)
Arginine (mg)	2842	None	- %	(6)
Histidine (mg)	1574	None	- %	(5)
Alanine (mg)	2469	None	- %	(6)
Aspartic Acid (mg)	4028	None	- %	(6)
Glutamic Acid (mg)	9801	None	- %	(6)
Glycine (mg)	2558	None	- %	(6)
Proline (mg)	3478	None	- %	(6)
Serine (mg)	2100	None	- %	(6)
Alcohol (Gm)	0	None	- %	(1)
Moisture (Gm)	645.9	None	- %	(3)
Ash (Gm)	9.018	None	- %	(5)
Caffeine (mg)	4	None	- %	(1)

Dietary Goal Analysis

test1
Custom Client Goals
University of Saskatchewan
Date: April 27, 1999



Exchanges

Starch/Breads:	19.3	Fruits:	.0
Meats:	4.5	Milk:	.3
Vegetables:	.0	Fats:	10.8

Macronutrients

	Your Intake	Goal Amount	Goal %
Calories	2155 Cals	2182 Kc	98 %
Protein	71.41 Gm	81.83 Gm	87 %
Carbohydrate	304.8 Gm	327.3 Gm	93 %
Fat	69.94 Gm	60.61 Gm	115 %
Saturated Fat	27.48 Gm	12.12 Gm	226 %
Mono Fat	25.4 Gm	24.24 Gm	104 %
Poly Fat	12.65 Gm	24.24 Gm	52 %
Other Fat	4.41 Gm	- Gm	- %
Cholesterol	189.4 mg	- mg	- %
Dietary Fiber	15.36 Gm	- Gm	- %
Sugar	89.65 Gm	- Gm	- %

Vitamins

	Your Intake	Goal Amount	Goal %
Vitamin A	597.5 RE	800.0 RE	74 %
Thiamin B1	1.101 mg	1.000 mg	110 %
Riboflavin B2	1.109 mg	1.300 mg	85 %
Niacin B3	17.49 mg	18.00 mg	97 %
Pyridoxine B6	1.24 mg	- mg	- %
Folate	171.5 Ug	120.0 Ug	142 %
Cobalamin B12	1.31 Ug	1.000 Ug	130 %
Vitamin E	2.891 mg	8.000 mg	36 %
A-Tocopherol	0.611 mg	- mg	- %
Pant. Acid	2.878 mg	- mg	- %
Biotin	9.197 Ug	- Ug	- %
Vitamin C	19.02 mg	25.00 mg	76 %
Vitamin D	2.096 Ug	2.500 Ug	83 %
Vitamin K	66.33 Ug	- Ug	- %

Minerals

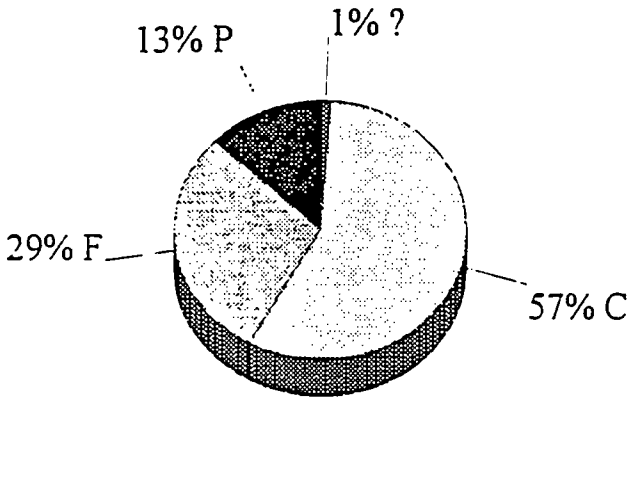
	Your Intake	Goal Amount	Goal %
Sodium	2066 mg	- mg	- %
Potassium	1488 mg	- mg	- %
Iron	9.889 mg	8.000 mg	123 %
Calcium	576.4 mg	900.0 mg	64 %
Magnesium	212.7 mg	130.0 mg	163 %
Phosphorus	991.8 mg	700.0 mg	141 %
Zinc	8.406 mg	9.000 mg	93 %
Copper	0.882 mg	- mg	- %
Manganese	3.236 mg	- mg	- %
Selenium	0.044 mg	- mg	- %
Fluoride	253.7 Ug	- Ug	- %
Chromium	0.089 mg	- mg	- %
Iodine	- Ug	125.0 Ug	- %
Molybdenum	5.883 Ug	- Ug	- %

Dietary Analysis

test1
Age: 12 Male
University of Saskatchewan
Date: April 27, 1999

Macronutrients

Calories	2155 Cals
Protein	71.41 Gm
Carbohydrate	304.80 Gm
Fat	69.94 Gm
Alcohol	0.00 Gm
Saturated Fat	27.48 Gm
Mono Fat	25.40 Gm
Poly Fat	12.65 Gm
Other Fat	4.41 Gm
Cholesterol	189.40 mg
Dietary Fiber	15.36 Gm
Sugar	89.65 Gm



Minerals

Sodium	2066 mg
Potassium	1488 mg
Iron	9.889 mg
Calcium	576.4 mg
Magnesium	212.7 mg
Phosphorus	991.8 mg
Zinc	8.406 mg
Copper	0.882 mg
Manganese	3.236 mg
Selenium	0.044 mg
Fluoride	253.7 Ug
Chromium	0.089 mg
Iodine	- Ug
Molybdenum	5.883 Ug

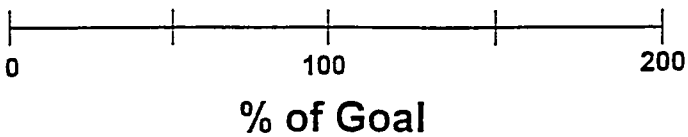
Vitamins

Vitamin A	597.5 RE
Thiamin B1	1.101 mg
Riboflavin B2	1.109 mg
Niacin B3	17.49 mg
Pyridoxine B6	1.24 mg
Folate	171.5 Ug
Cobalamin B12	1.31 Ug
Vitamin E	2.891 mg
A-Tocopherol	0.611 mg
Pant. Acid	2.878 mg
Biotin	9.197 Ug
Vitamin C	19.02 mg
Vitamin D	2.096 Ug
Vitamin K	66.33 Ug

Graphic Analysis

Name: test1
Goal: Custom Client Goals
Company: University of Saskatchewan
April 27, 1999

Kilocalories	98 %	2155 Kc
Protein	87 %	71.41 Gm
Carbohydrate	93 %	304.8 Gm
Fat	115 %	69.94 Gm
Cholesterol	- %	189.4 mg
Saturated Fat	226 %	27.48 Gm
Mono Fat	104 %	25.4 Gm
Poly Fat	52 %	12.65 Gm
Dietary Fiber	- %	15.36 Gm
Sodium	- %	2066 mg
Iron	123 %	9.889 mg
Calcium	64 %	576.4 mg
Magnesium	163 %	212.7 mg
Phosphorus	141 %	991.8 mg
Zinc	93 %	8.406 mg
Selenium	- %	0.044 mg
Iodine	- %	- Ug
Vitamin A	74 %	597.5 RE
Vitamin D	83 %	2.096 Ug
Vitamin E	36 %	2.891 mg
Vitamin K	- %	66.33 Ug
Thiamin B1	110 %	1.101 mg
Riboflavin B2	85 %	1.109 mg
Niacin B3	97 %	17.49 mg
Pyridoxine B6	- %	1.24 mg
Folate	142 %	171.5 Ug
Cobalamin B12	130 %	1.31 Ug
Pant. Acid	- %	2.878 mg
Vitamin C	76 %	19.02 mg



% of Goal

test1

Average Daily Nutrient Values

Macronutrients		
Kilocalories	2155	Kc
Protein	71.41	Gm
Carbohydrate	304.8	Gm
Fat	69.94	Gm
Alcohol	0.000	Gm
Fats		
Cholesterol	189.4	mg
Saturated Fat	27.48	Gm
Mono Fat	25.40	Gm
Poly Fat	12.65	Gm
Carbohydrates		
Dietary Fiber	15.36	Gm
Soluble Fiber	0.350	Gm
Insol. Fiber	1.515	Gm
Sugar	89.65	Gm
Vitamins		
Vitamin A	597.5	RE
Beta-Carotene	25.96	Ug
Vitamin E	2.891	mg
A-Tocopherol	0.611	mg
Thiamin B1	1.101	mg
Riboflavin B2	1.109	mg
Niacin B3	17.49	mg
Pyridoxine B6	1.240	mg
Folate	171.5	Ug
Cobalamin B12	1.310	Ug
Pant. Acid	2.878	mg
Biotin	9.197	Ug
Vitamin C	19.02	mg
Vitamin D	2.096	Ug
Vitamin K	66.33	Ug
Amino Acids		
Tryptophan	668.1	mg
Threonine	2050	mg
Isoleucine	2540	mg
Leucine	4018	mg
Lysine	3901	mg
Methionine	1268	mg
Phenylalanine	2306	mg
Valine	2730	mg
Misc.		
Weight	1127	Gm
Moisture	645.9	Gm
Ash	9.018	Gm
Caffeine	4.000	mg
Minerals		
Sodium	2066	mg
Potassium	1488	mg
Iron	9.889	mg
Calcium	576.4	mg
Magnesium	212.7	mg
Phosphorus	991.8	mg
Zinc	8.406	mg
Copper	0.882	mg
Manganese	3.236	mg
Selenium	0.044	mg
Fluoride	253.7	Ug
Chromium	0.089	mg

Appendix H

Notices to recruit children for the study

Dear Fellow Graduate Students,

I am doing a study on children's dietary intakes and physical activity. 24-hour recall used to assess the dietary intakes and physical activity measured using physical activity questionnaire, activity diary and caltrac.

I would like to know whether you have/know any child between the ages of 6 to 15 years who would be willing to participate in my study. If you know anyone interested, could you please send me the details to contact.

put181@mail.usask.ca

Tel: 374-4916(h)
966-6912(o)

(This study received university ethics approval and already 30 subjects participated to date)

Thank you

E-mail notice sent to College of Pharmacy and Nutrition graduate students.

Appendix I

Anthropometry data

Anthropometry data

Subject Number	**Sex**	**Age** (years)	**Weight** (kg)	**Height** (cm)	**Head circumference** (cm)	**Tricep skinfold thickness** (mm)
1	Male	6	21.4	119.4	54.0	11.0
2	Male	6	29.5	129.5	52.5	11.0
3	Male	7	18.2	115.0	52.0	NA
4	Male	7	21.4	125.7	53.0	10.5
5	Male	7	29.1	129.5	53.0	11.0
6	Male	8	28.8	128.9	54.5	8.5
7	Male	8	22.7	124.5	51.0	12.0
8	Male	8	27.7	124.5	49.0	14.0
9	Male	8	34.1	134.6	54.0	15.0
10	Male	9	25.5	124.5	53.5	15.0
11	Male	9	23.9	133.4	52.0	10.5
12	Male	9	27.3	138.4	55.0	14.0
13	Male	10	28.2	142.2	53.6	9.0
14	Male	10	32.3	142.2	55.0	8.0
15	Male	11	39.5	142.2	55.0	15.0
16	Male	11	38.6	154.9	54.5	8.0
17	Male	11	40.9	154.9	53.0	14.3
18	Male	11	31.4	141.0	54.0	8.0
19	Male	12	53.6	155.6	55.0	14.5
20	Male	12	33.2	143.5	53.0	5.0
21	Male	12	44.1	144.8	55.5	8.0
22	Male	13	45.5	157.5	54.0	NA
23	Male	14	70.9	175.3	59.0	10.3
24	Male	15	59.1	165.1	55.0	8.0
25	Female	6	21.2	111.8	53.0	14.0
26	Female	6	18.2	114.3	48.7	9.0
27	Female	6	22.7	118.1	51.4	13.0
28	Female	6	17.3	111.8	53.0	10.0
29	Female	6	16.4	109.2	53.5	9.0
30	Female	7	30.9	127.6	53.0	14.5
31	Female	7	20.0	114.3	50.0	NA
32	Female	7	21.8	119.4	54.0	11.5
33	Female	8	20.5	121.9	51.5	13.5
34	Female	8	25.0	129.5	50.3	9.0
35	Female	8	24.5	123.2	54.0	12.0
36	Female	9	45.5	146.1	55.0	17.5
37	Female	10	34.1	146.1	54.5	11.0
38	Female	10	33.2	138.4	52.0	13.0
39	Female	10	26.8	132.1	53.0	14.0
40	Female	10	36.8	142.2	52.0	15.0
41	Female	11	33.6	132.3	51.5	15.0
42	Female	11	40.5	146.1	53.5	NA

43	Female	11	44.1	134.6	54.0	18.0
44	Female	11	33.5	152.4	54.5	12.0
45	Female	12	39.5	149.9	57.0	13.0
46	Female	13	40.9	153.7	56.0	8.0
47	Female	14	53.6	160.0	55.0	14.0
48	Female	14	50.0	161.3	53.5	8.0
49	Female	15	76.4	175.3	55.9	15.0
50	Female	15	63.2	171.5	57.5	14

NA= Not available

Age
Total number:50
Mean:9.7 years
Standard Deviation:2.7 years
Median:10 years
Range: 6-15 years

Weight
Total number:50
Mean:34.3kg
Standard Deviation:13.7kg
Median:31.8kg
Range:16.3-76.3kg

Height
Total number:50
Mean:137.8cm
Standard Deviation:17.2cm
Median:136.5cm
Range:109.2-175.2cm

Head Circumference
Total number:50
Mean:53.5cm
Standard Deviation:1.9cm
Median:53.8cm
Range:48.7-59.0cm

Triceps skinfold thickness
Total number:46
Mean:11.8mm
Standard Deviation:2.9mm
Median:12mm
Range:5-18mm

Appendix J

Macronutrient intake data

Macronutrient intake data

Subject Number	Calorie Intake (kcal)	Protein Intake (g)	Carbohydrate Intake (g)	Fat Intake (g)
1	1258	39.7	236.0	18.1
2	1250	37.2	164.7	50.6
3	1547	64.6	211.4	49.2
4	1776	59.3	238.7	68.9
5	1779	72.7	213.3	73.1
6	2001	85.3	251.8	75.2
7	1669	56.1	258.5	43.7
8	1376	51.2	202.5	42.8
9	1183	55.1	166.4	33.8
10	1767	81.6	197.0	77.0
11	1353	55.0	196.6	40.9
12	1942	65.7	261.7	74.4
13	2363	80.3	361.3	76.1
14	1050	39.5	154.8	31.2
15	2549	60.1	418.7	77.5
16	1380	61.7	175.3	49.9
17	1789	74.0	242.2	61.0
18	1236	50.3	166.7	42.5
19	1257	48.6	177.0	42.7
20	1595	46.4	207.4	66.6
21	1847	83.4	202.9	80.3
22	1613	50.8	221.5	60.5
23	1778	53.4	247.4	67.2
24	1338	60.1	188.3	38.4
25	886	39.4	125.5	26.5
26	1293	48.7	187.3	41.8
27	1366	55.1	174.2	51.9
28	1131	58.7	149.5	33.7
29	1236	60.1	164.2	38.3
30	1125	35.6	167.4	38.2
31	1245	37.3	167.4	52.2
32	1114	29.9	182.9	31.4
33	1171	57.8	151.3	38.1
34	1395	48.8	218.0	40.9
35	1189	41.7	175.6	38.2
36	1503	58.9	203.1	52.5
37	1555	56.9	235.4	44.5
38	1577	61.9	239.6	45.2
39	1016	51.3	128.2	35.3
40	1392	54.7	184.8	46.6
41	1549	57.7	189.1	65.7
42	2157	77.1	313.4	74.3
43	2114	72.2	339.7	53.4

44	1034	56.5	134.9	30.8
45	1289	52.3	193.5	35.2
46	1320	51.8	160.2	53.7
47	1201	45.0	209.9	23.1
48	1247	81.0	138.1	42.0
49	1375	39.2	234.2	35.8
50	1311	55.6	192.9	38.2

Calorie Intake
Total number:50
Mean:1469 kcal
Standard Deviation:356 kcal
Median:1370 kcal
Range:885-2549 kcal

Protein Intake
Total number:50
Mean:56.3g
Standard Deviation:13.3g
Median:55.3g
Range:29.8-85.3g

Carbohydrate Intake
Total number:50
Mean:206.4g
Standard Deviation:57.8g
Median:195.0g
Range:125.5-418.7g

Fat Intake
Total number:50
Mean:48.9g
Standard Deviation:16.1g
Median:44.1g
Range:18.1-80.2g

Appendix K

Micronutrient intake data

Micronutrient intake data

Subject Number	Calcium (mg)	Iron (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Folate (μg)
1	897	17.0	1.00	1.23	8.9	170
2	550	7.7	.85	1.09	13.3	88
3	1150	10.0	1.25	1.81	13.0	170
4	908	9.2	1.66	1.77	14.0	240
5	1180	11.6	1.15	1.79	16.1	256
6	929	15.7	1.48	2.11	21.2	308
7	630	19.9	2.65	1.37	18.1	297
8	1080	9.5	1.16	1.46	10.5	134
9	792	7.9	1.04	1.46	9.2	119
10	802	13.7	2.46	1.52	22.9	306
11	513	16.6	1.37	1.45	16.8	243
12	921	9.5	1.60	1.76	14.9	203
13	1093	13.8	1.94	2.24	23.8	431
14	498	9.0	.79	1.04	9.8	101
15	1692	19.0	3.39	1.64	18.4	491
16	966	9.4	1.34	1.39	10.8	166
17	1470	11.0	1.50	1.97	11.4	218
18	534	19.3	1.50	1.90	16.6	293
19	944	20.3	1.48	1.53	11.8	318
20	613	10.6	1.23	1.27	10.9	213
21	786	9.3	1.00	1.51	11.8	133
22	420	8.8	.69	.90	10.9	113
23	653	14.5	1.77	1.03	15.1	420
24	927	8.6	1.11	1.78	9.8	132
25	578	8.3	.79	1.23	9.8	112
26	872	10.1	1.40	1.43	11.5	203
27	1068	9.9	1.33	1.87	12.7	196
28	572	8.7	.99	1.02	13.6	117
29	1179	7.4	1.02	1.22	13.8	107
30	672	11.8	.94	1.08	7.1	225
31	200	7.8	.55	.60	8.9	90
32	370	8.7	1.12	.91	11.4	220
33	912	11.4	1.14	1.68	14.6	153
34	727	11.0	1.41	1.26	13.8	201
35	847	10.5	1.16	1.58	10.1	160
36	761	27.9	1.86	1.76	15.9	392
37	556	7.5	1.17	1.02	12.5	184
38	1235	8.9	1.26	1.79	14.7	178
39	530	12.8	.83	1.07	14.5	142
40	1122	8.8	1.31	1.46	7.9	116
41	918	8.8	1.82	1.05	10.7	176
42	1918	15.2	1.29	2.47	1.5	240
43	806	12.9	1.82	1.74	23.9	246
44	492	9.1	1.14	1.19	18.5	160

45	1202	12.7	1.60	1.96	11.0	216
46	452	8.1	.95	1.03	12.3	102
47	546	12.0	1.66	1.24	12.6	241
48	577	18.0	1.67	1.79	33.2	272
49	884	6.2	.89	1.71	1.2	221
50	357	13.0	1.07	1.41	21.3	222

Calcium
Total number:50
Mean:825
Standard Deviation:337
Median:803
Range:200-1918

Iron
Total number:50
Mean:11.7 mg
Standard Deviation:4.2 mg
Median:10.3 mg
Range:6.1-27.8 mg

Thiamin
Total number:50
Mean:1.35 mg
Standard Deviation:0.50 mg
Median: 1.25 mg
Range: 0.55-3.39 mg

Riboflavin
Total number:50
Mean:1.35 mg
Standard Deviation:0.50 mg
Median:1.25 mg
Range:0.55-3.39 mg

Niacin
Total number:50
Mean:13.5 mg
Standard Deviation:5.4 mg
Median:12.6 mg
Range:1.1-33.1 mg

Folate
Total number:50
Mean:209 µg
Standard Deviation:91 µg
Median:201 µg
Range:87-491 µg

Micronutrient intake data

Subject Number	**Vitamin C** (mg)	**Vitamin A** (RE)	**Vitamin B6** (mg)	**Vitamin B12** (μg)	**Magnesium** (mg)
1	101	639	.81	1.56	138
2	43	244	.52	1.71	96
3	113	773	1.13	2.84	199
4	149	2643	1.67	3.00	248
5	89	784	.97	3.55	183
6	186	1878	1.45	4.32	208
7	204	3380	2.00	2.02	219
8	87	837	1.26	2.30	161
9	32	469	.77	3.49	175
10	24	785	1.25	2.14	374
11	68	907	.91	2.72	179
12	143	2041	1.48	3.34	222
13	215	2680	1.46	3.15	335
14	67	679	.37	.69	86
15	293	2609	2.35	2.14	264
16	108	1527	.80	1.80	242
17	89	1031	1.06	2.95	259
18	54	806	1.59	1.79	128
19	78	582	1.31	2.99	238
20	96	1377	.70	2.02	156
21	34	633	1.26	3.56	154
22	103	344	1.28	2.53	159
23	64	299	1.52	1.44	296
24	26	394	1.16	3.78	201
25	38	1004	.81	2.02	129
26	133	1092	.95	1.99	237
27	81	482	1.02	2.94	162
28	52	456	.96	1.29	133
29	42	486	.88	2.02	143
30	94	348	.78	2.37	181
31	37	229	1.11	2.14	118
32	71	352	1.71	1.33	164
33	28	3152	1.10	2.82	169
34	269	2089	1.26	1.60	234
35	86	759	1.10	1.95	160
36	85	504	1.63	4.12	333
37	91	320	.84	1.87	192
38	205	1211	1.04	4.02	214
39	215	1872	1.34	3.07	152
40	39	721	.76	2.35	152
41	33	736	1.00	1.19	288
42	154	1453	1.54	3.57	383
43	234	460	.82	1.07	193

44	83	438	1.21	2.56	156
45	28	670	.89	3.05	174
46	23	399	1.01	2.14	132
47	26	446	.81	2.01	106
48	35	691	1.96	2.03	195
49	83	871	1.17	2.44	185
50	37	837	2.12	1.41	173

Vitamin C
Total number:50
Mean:95 mg
Standard Deviation:68 mg
Median:83 mg
Range:23-292 mg

Vitamin A
Total number:50
Mean:1008RE
Standard Deviation:788 RE
Median:747 RE
Range:229-3380 RE

Vitamin B6
Total number:50
Mean:1.17 mg
Standard Deviation:0.40 mg
Median:1.10 mg
Range:0.37-2.35 mg

Vitamin B12
Total number:50
Mean:2.42 μg
Standard Deviation:0.84 μg
Median:2.21 μg
Range:0.69-4.32 μg

Magnesium
Total number:50
Mean:195 mg
Standard Deviation:67 mg
Median:179 mg
Range:67-85 mg

Appendix L

Physical Activity data

Physical activity data

Subject Number	**PAQ-C** (1-5 Scale)	**Activity Diary energy expenditure** (kcal)	**Caltrac energy expenditure** (kcal)
1	1.67	384	1799
2	1.62	574	NA
3	3.70	357	604
4	3.28	397	1120
5	3.95	320	1720
6	3.03	469	512
7	3.36	566	750
8	3.55	583	1222
9	3.01	513	1511
10	4.02	412	508
11	3.21	399	1368
12	2.77	464	1252
13	2.65	481	453
14	3.89	565	1422
15	2.70	540	2117
16	3.04	538	355
17	2.65	503	851
18	NA	756	290
19	2.12	606	1804
20	4.02	601	1870
21	3.46	610	775
22	2.91	NA	NA
23	2.71	1311	2176
24	2.47	1174	1918
25	2.42	247	1079
26	3.02	356	623
27	3.38	507	1174
28	3.08	562	665
29	3.09	549	590
30	2.39	315	905
31	2.63	NA	NA
32	2.62	375	910
33	2.34	243	1310
34	2.90	447	741
35	2.86	562	523
36	2.07	404	1621
37	2.97	561	1400
38	3.02	824	1460
39	2.18	435	1125
40	3.64	592	1355
41	2.99	463	540
42	2.87	909	1115

43	2.41	508	1664
44	3.06	819	978
45	3.04	740	425
46	3.21	1100	1721
47	2.86	NA	NA
48	3.45	1307	2407
49	2.30	568	2475
50	1.77	573	4012

NA= Not available

PAQ-C (1-5 Scale)
Total number:49
Mean:2.94
Standard Deviation:0.56
Median:3.00
Range:1.67-4.02

Activity Diary energy expenditure
Total number:47
Mean:572 kcal
Standard Deviation:248 kcal
Median:537 kcal
Range:242-1310 kcal

Caltrac energy expenditure
Total number:46
Mean:1265 kcal
Standard Deviation:700 kcal
Median:1174 kcal
Range:355-4012 kcal

Type of physical activities used to determine energy expenditure using activity diary

- Bicycling
- Dancing
- Home activities
  - Carpet sweeping, sweeping floors
  - Cleaning
  - Walking shopping
  - Party
  - Playing (indoor)
- Inactivity, quiet
  - Drawing
  - Home works from school
  - Reading
  - Religious activities
  - Sitting
  - Sleeping
  - Studying
  - Talking
  - Walking
  - Watching television/video
  - Writing
  - Video/computer games
- Lawn and garden
  - Mowing
  - Raking
  - Watering
  - Weeding
- Miscellaneous
  - Bus/car rides
  - Grocery, shopping
  - Sitting card playing
- Music playing
  - Music lessons
  - Piano
- Outdoor activities
- Running
- School activities
  - Studing
- Self-care
  - Eating
  - showering
- Sports
  - Baseball
  - Basketball

- Football
- Gymnastics
- Hockey: field/ice
- Physical education
- Rope jumping
- Soccer
- Street hockey
- Swimming

Walking

Water activities
- Swimming

Winter activities
- Skating
- Skiing
- Sledding

Appendix M

Energy balance data

Energy balance data

Subject Number	**Energy intake** (kcal)	**Resting energy expenditure** (kcal)	**Energy expenditure based on activity diary** (kcal)	**Energy balance** (kcal)
1	1258	980	384	-106
2	1250	1166	574	-490
3	1547	908	357	282
4	1776	980	397	399
5	1779	1155	320	304
6	2001	1149	469	383
7	1669	1011	566	92
8	1376	1124	583	-331
9	1183	1269	513	-599
10	1767	1073	412	282
11	1353	1037	399	-83
12	1942	1114	464	364
13	2363	1135	481	748
14	1050	1228	565	-742
15	2549	1343	540	666
16	1380	1327	538	-485
17	1789	1367	503	-81
18	1236	1200	756	-720
19	1257	1590	606	-938
20	1595	1232	601	-238
21	1847	1423	610	-185
22	1613	1446	NA	NA
23	1778	1892	1311	-1424
24	1338	1685	1174	-1521
25	886	976	247	-337
26	1293	908	356	29
27	1366	1010	507	-152
28	1131	888	562	-318
29	1236	867	549	-180
30	1125	1194	315	-384
31	1245	949	NA	NA
32	1114	990	375	-250
33	1171	960	243	-31
34	1395	1062	447	-113
35	1189	1051	562	-424
36	1503	1522	404	-423
37	1555	1266	561	-272
38	1577	1246	824	-492
39	1016	1102	435	-521
40	1392	1327	592	-527

41	1549	1156	463	-70
42	2157	1239	909	8
43	2114	1284	508	322
44	1034	1154	819	-940
45	1289	1228	740	-680
46	1320	1245	1100	-1025
47	1201	1400	NA	NA
48	1247	1356	1307	-1416
49	1375	1678	568	-871
50	1311	1517	573	-779

NA= Not available

Energy intake
Total number:50
Mean:1477 kcal
Standard Deviation:363 kcal
Median:1375 kcal
Range:885-2549 kcal

Resting energy expenditure
Total number:50
Mean:1204 kcal
Standard Deviation:223 kcal
Median:1165 kcal
Range:867-1891 kcal

Energy expenditure based on activity diary
Total number:47
Mean:576 kcal
Standard Deviation:244 kcal
Median:539 kcal
Range:242-1310 kcal

Energy balance
Total number:47
Mean:-303 kcal
Standard Deviation:517 kcal
Median:-271 kcal
Range:-1521-747 kcal