University of Alberta

Type 2 Diabetes: Economics of Dietary Adherence

by

Denise Maxwell

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural and Resource Economics

Department of Rural Economy

Spring 2011
Edmonton, Alberta

Examining Committee

Sven Anders; Department of Rural Economy

Sean B. Cash; Department of Rural Economy

Catherine Chan; Department of Agriculture, Food and Nutritional Sciences

Abstract

This thesis examines the economic and time barriers to dietary adherence for T2D patients living in Edmonton by using utility theory, household production theory and the concept of health capital. Socio-demographic, food consumption, food purchase and time use information was obtained by administering a questionnaire and a food record; collecting grocery receipts and a blood sample; conducting a telephone interview, and taking measurements. Multivariate regression analysis and correlations showed a negative association between fruit and vegetable expenditure and A_{1c}. Diet quality was negatively associated with A_{1c} and total food expenditure but had an inverted U-shaped association with income. While working time was negatively correlated with diet quality and positively correlated with A_{1c}, regression analysis showed a negative association between working time and diet quality only among higher income participants. Budget constraints and time constraints appear to be the barriers to dietary adherence among low-income and high-income patients, respectively.

Acknowledgements

I would like to thank the many people involved in helping to put this study together. Firstly, I thank Gayathiri Devi Duraj from AFNS for helping with data collection and data entry. As I think back on the summer of 2009, I remember the fun times and laughs we had as we scheduled participants and held information sessions. We made a good team! The data collection process also went smoothly with the help of Jeanine (Jeanie) Glassford, who provided much needed assistance during the instrument development and data collection phases. Thanks Jeanie, for lending assistance in any way you could. Your upbeat, energetic manner was greatly appreciated during those very busy times.

Thanks to the participants who have generously volunteered their time and energy so we could have accurate data, as well as the students and community members who tested our instruments and have given us valuable feedback. A special thank you to Stephanie Babwik for volunteering time to enter data, in spite of a hectic undergraduate class schedule.

A big thanks to Dana and Marcus who have provided space at the Human Nutrition Research Unit for us to hold sessions with participants and to Abha and Fatheema, who trained both Jeannie and Gayathiri in blood sample collection and in the use of the A_{1c} machine and in measurement technique, respectively. Thanks also to Tanya Berry for lending private office space to contact participants and the staff at the Physical Education department for the use of the laptop.

Finally, I would like to thank PANDA team members who have given assistance throughout the study: Sven Anders (supervisor), Sean Cash (co-supervisor), Rhonda Bell (project team member – nutrition) and Cathy Chan (committee member and principle investigator of PANDA).

This project was funded by The University of Alberta Faculty of Medicine and Dentistry and the Department of Rural Economy; Alberta Health Services, Capital Health Region. Additional funding was provided by the University of Wisconsin - Madison Graduate School.

Table of Contents

List of Tables

List of Figures

List of abbreviations and definitions

Abbreviation	Name	Definition
A_{1c} or HbA_{1c}	Hemoglobin A_{1c}	A proxy for long-term blood glucose
AI	Adequate Intake	The level of intake of a nutrient that has been observed in people in a healthy group (Stipanuk, 2000)
BMI	Body Mass Index	An index used to estimate health risks associated with obesity. BMI is calculated as the ratio of mass to squared height (Kg/M^2)
CDA	Canadian Diabetes Association	As part of their mandate, the CDA provides people with diabetes and healthcare professionals with education and services (CDA, 2011)
DQI	Diet Quality Index	An index of diet quality
DQI-I	Diet Quality Index - International	A variant of DQI. DQI-I considers differences in RDA and AI across countries
HEI	Healthy Eating Index	An index of diet quality
IU	International Units	A standard measure used to quantify supplements.
OLS	Ordinary Least Squares	A regression analysis used when the dependent variable is continuous
PANDA	Physical Activity and Nutrition for Diabetes in Alberta	A set of multi-faceted programs designed to help people with T2D overcome barriers to diet and physical activity recommendations.
PUFA	Polyunsaturated Fatty Acids	Fatty acids containing two or more double bonds (Stipanuk, 2000). These fatty acids are essential for human biochemical functions
RDA	Recommended Daily Allowance	Dietary intake that will meet nutritional requirements of approximately 97% of the people in a specific group (Stipanuk, 2000)
SFA	Saturated Fatty Acids	Fatty acids containing no double bonds (Stipanuk, 2000). Consumption of SFA has been linked to cardiovascular disease.
T2D	Type 2 Diabetes	A disease characterized by the body's inability to use glucose properly, resulting in increased blood glucose.

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

The topic of this thesis is *economics of dietary adherence for type 2 diabetes patients*. This chapter provides the background information necessary to explore the possible answers to the research question: *What are the economic and time use factors associated with adherence to an appropriate eating plan for type 2 diabetes patients?* In this chapter, the economic importance of health and healthcare in Canada is discussed, particularly as it pertains to T2D treatment and management. The link between human behaviour and certain diseases is also discussed. The PANDA project (*Physical Activity and Nutrition for Diabetes in Alberta*) is introduced as a toolbox for development of an effective T2D intervention plan.

In order to answer the research question, it is necessary to analyze consumption behaviour as well as general human behavioural tendencies as they pertain to the economics of health and the healthcare system in Canada. Information on diet, demographics, time use, income and other factors can be modeled to determine perceived and actual barriers to following an appropriate diet. Intervention strategies aimed at encouraging healthy eating behaviour can be developed from the results of the analysis.

Human behaviour is often contradictory. We desire good health, but engage in behaviour that we know will contribute to ill health. For example, many people smoke, knowing that there are health risks and no health benefits associated with tobacco use. Understanding the reasons for this contradictory behaviour and determining the barriers to behaviours conducive to good health may be the first step in health improvement, especially for those struggling with health issues such as obesity, cardiovascular disease and diabetes. The behaviours conducive to poor health are directly responsible for the economic problem discussed in this thesis: failure of markets to maximize social welfare.

1.2 Market failure and moral hazard

We live in a capitalist society; we buy and sell goods and services. *Market failure* occurs at any point where net market gains are not maximized and resources are not being allocated as efficiently as possible, resulting in less than optimal (i.e. less than maximum) social welfare. One of the causes of market failure is *externality*, which is the uncompensated direct effect of one agent's economic decision on another economic agent (Binger and Hoffman, 1998).

Externalities are common and often occur unintentionally. Examples of negative externalities include pollution emissions from mines, offensive odours from livestock farming operations and noise from construction in residential areas. The externality is created as a result of the activity of the person or company.

There are several ways to improve social welfare to the optimal level but ultimately the end result is that the actions that have created the externalities are changed, reduced or halted. Social welfare optimization is often achieved by implementing taxes, subsidies, regulations or government policy interventions. These measures encourage people to make the changes necessary to reduce or eliminate the externality.

Net social welfare is the difference between net social cost and net social benefit. Although externalities result in reduced social welfare, maximum social welfare may exist in the presence of externalities, due to the social benefit resulting from the externalities. For example, a fast food chain may contribute to obesity and increased risk of disease and disorders associated with obesity (creating an externality due to the increased use of scarce healthcare resources), but will employ hundreds of people and add substantially to GDP. The goal for policymakers is to determine the optimal balance between the undesired and desired effects of the externalities (i.e. the point of maximum social welfare).

Universal healthcare exists in Canada. Necessary surgical procedures, hospitalization and sometimes drugs, are covered under provincial healthcare

plans and are provided by taxes. While most Canadians prefer equality in healthcare use regardless of personal economic situation, universal healthcare results in an inefficient allocation of healthcare dollars. Inefficiency is evident as those who use a larger portion of this resource, often through unhealthy lifestyle choices, pay the same price for the resource as those who use very little of it.

The cost of healthcare is substantial in Canada. Healthcare spending comprises the largest share of the provincial government spending in Canada and has increased significantly from 1988-2004 (Landon et al., 2006). People who engage in unhealthy lifestyle choices are imposing their own healthcare costs onto society, creating a negative externality for taxpayers. As suggested by Kennedy (2010), a moral hazard may also be created by individuals who lead unhealthy lifestyles: lack of incentive to follow a healthy lifestyle may result from not being responsible for the costs incurred by one's own ill health. However, due to differences in priorities, differences in utility derived from good health and different propensities to engage in unhealthy or risky behaviours, some citizens may be much more predisposed to incur moral hazard and/or externalities relating to healthcare than others, creating a further imbalance in the system.

1.3 Policy interventions and health programs

Negative externalities exist wherever a company, producer or individual imposes costs of their actions onto society. Common examples of externalities created by individuals are playing loud music when neighbours are trying to sleep, cutting people off in traffic and smoking in a public place. Smoking, even in a private home, could create a negative externality to society as a whole indirectly, through the increased use of healthcare resources caused by the ill effects of smoking on the health of the smoker.

Risk of developing many diseases is increased through unhealthy lifestyle choices. Smokers are often aware of the risks associated with smoking. Many people following a poor diet and lifestyle and are obese and unfit are also aware of the risks to their health, but seem unwilling and/or unable to change their

behaviour. Alcoholics and drug addicts also face serious health risks but often do not change their self-destructive behaviours on their own. The healthcare costs of these behaviours are significant and are largely paid for by all members of society. Treatment and management of obesity-related co-morbidities use a considerable portion of the healthcare dollars in Canada (Birmingham et al., 1999). Treatment costs are provided by society, through taxes.

Many interventions are aimed at helping people change unhealthy or risky behaviours. The goal of these intervention strategies is to improve the health of the population targeted in the intervention. Interventions aimed at encouraging people to quit smoking (or discourage them from starting) have been successful (Murray et al., 2002; Lewit et al., 1997). However, although programs that encourage people to make healthy choices to prevent disease or co-morbidities are widely available (Cobb et al., 2006; Orchard et al., 2005; Wing et al., 1998), other factors encouraging Canadians to lead an unhealthy lifestyle often dominate. Unless effective intervention strategies are developed and implemented, there will likely be an increase in the incidence of co-morbidities in people with diseases like T2D, due to the continued (and possibly growing) accessibility to factors contributing to an unhealthy lifestyle.

It is possible to reduce this societal cost by minimizing the number and severity of co-morbidities and the costs associated with T2D by careful behaviour modification through diet and exercise. The economic benefit to society will far outweigh the additional costs incurred by the intervention. Understanding the barriers to dietary adherence could be a step towards a healthier lifestyle for T2D patients, putting less strain on the Canadian healthcare system and improving social welfare.

1.4 Genetics, lifestyle, behaviour and health

Most of us are aware of the importance of diet and physical activity for the health of the general population and for people with chronic conditions, such as diabetes, in particular. Healthcare professionals recommend changes in diet and physical

activity as the first line of treatment for people with T2D. However, dietary adherence appears to be difficult for patients. Since very little research has been done to determine barriers to adherence to a diet plan, factors associated with dietary adherence are still unclear. Possible barriers are many, and probably include a combination of genetic and environmental factors.

Physically and mentally, each of us is unique. We have unique strengths, weaknesses and abilities, arising from the genes we have inherited from our parents and the experiences we continually receive from the environment. Our physical appearance and behavioural patterns are influenced by genetics, environment or, most often, a combination of both. Likewise, health outcomes are determined by genetics, environment and behaviour (Stipanuk, 2000).

It is often difficult to distinguish between the influence of genes and the influence of environment. However, there is evidence that both are involved in numerous human physical, psychological and health outcomes, from muscularity and athletic performance, to skin pigmentation, to development of certain diseases and conditions such as diabetes (Hardin, 1952).

1.5 Lifestyle choices

Environment strongly influences the outward expression of many traits. Environment includes where one works and lives, along with the food choices we have available, the stresses we face and the conditions and risks to which we are exposed. Behavioural characteristics, which can often be changed or modified, are collectively referred to as *lifestyle*. Some lifestyle behaviours include alcohol consumption, smoking, physical activity and dietary habits (Mulder et al., 1998).

Lifestyle includes, among other things, diet, leisure activities, work environment, exercise and activity. For example, "a healthy lifestyle" refers to following a diet and exercise plan known to be conducive to good health, managing stress well, and maintaining healthy and balanced relationships with friends and family. An "unhealthy lifestyle" may include high-risk activities, such as illegal drug use, speeding, engaging in unsafe sex, and excessive use of alcohol

and/ or overeating on a regular basis. An unhealthy lifestyle increases the risk of disease and/or premature death. Lifestyle behaviours, however, are subject to change and can be modified, given appropriate environmental conditions (Mulder et al., 1998).

Because Canada is a wealthy nation, there are high standards for food quality, drinking water quality, housing and healthcare. Most of us have considerable capacity to choose our lifestyle and modify our environment. We can choose what we eat, how to spend our leisure time and where to work and live. Since we can change or modify certain aspects of our environment, some physical and mental health outcomes are in our control to some degree.

Although some diseases result solely from genetic factors, many diseases and conditions arise from a combination of genetic susceptibility and an unhealthy lifestyle. Obesity, lack of exercise, poor diet and high mental and emotional stress, common in North America, increase the likelihood of acquiring many diseases of the industrialized world. Genetic and environmental factors that increase the susceptibility to acquiring a disease are called risk factors. An increase in the number of risk factors increases the likelihood of getting a disease. Behavioural modifications can reduce the risk of developing diseases such as T2D. Prevalence of this disease is far more common in modern times than centuries or even a decade ago and is more prevalent in industrialized nations than in the developing world. However, in recent years, the prevalence of diabetes has increased in developing countries as well, paralleling changes in lifestyle and behaviour (Zimmet et al., 2001).

1.6 The connection between environmental changes and human behaviour

Change in environment brings change in behaviour. A behavioural change could be as simple as a change in type of clothing with changing seasons. More dramatic behavioural changes could come about after moving to a different country, with different food, customs, clothing styles, laws and language. Other behavioural changes result from educational experiences, changes in health status,

traumatic experiences or job changes, to name a few. A change in socio-economic status may increase opportunities to acquire possessions and provide a wider range of choices for food, recreation, transportation and travel.

An increase in income could increase accessibility to resources and allow us to increase consumption. Likewise, shorter commuting times could increase access to resources and could also result in an increase in consumption. An increase in both availability and accessibility may lead to overconsumption of certain foods or total energy intake. Kim et al. (2003) found that disparity between availability and prudence in intake among Americans appeared to have caused an imbalance in the American diet, leading to overnutrition. Overconsumption of certain types of foods is what has happened, and continues to happen, in Canada and other industrialized nations.

1.7 Lifestyle and health in Canada

The wealthiest nations in the world are fat, and getting fatter. Prevalence of overweight and obesity in Canada has increased substantially from 1985-2003 **(**Katzmarzyk and Mason, 2006). While the cause of this phenomenon is not fully understood and is likely complex and multi-factorial, there is a definite association between obesity and consumption of energy dense (high calorie) foods combined with a sedentary lifestyle. With few exceptions, we have sedentary occupations, a vehicle, automated household appliances and sedentary leisure entertainment. The combination of inactivity with the abundance of low-cost, high calorie food can result in excessive calorie consumption.

This is a concern because being obese and unfit has serious health implications. Compared with normal weight people, the odds are significantly higher for overweight individuals to have asthma, arthritis, back problems, high blood pressure, diabetes, thyroid problems, activity limitations, and repetitive strain injuries (Statistics Canada, 1999). These health issues affect quality of life. Some diseases strongly associated with obesity, such as T2D, also have a negative effect on life expectancy and are costly to the healthcare system.

1.8 Diabetes mellitus

Blood glucose control is important for general health. For most people, the body controls blood glucose levels with a complex interaction between the hormones insulin and glucagon (Stipanuk, 2000). People with *diabetes mellitus* (commonly called diabetes) cannot control blood glucose naturally; it is very important for these people to monitor and control blood glucose. If not controlled, serious complications may occur, leading to reduced quality of life and lower life expectancy (American Diabetes Association, 2009). Manuel and Schultz (2004) found the average life expectancy for diabetic patients in Ontario to be 65 and 71 years for men and women, respectively (12-13 years younger than that of the general population).

1.8.1 Types of diabetes

There are three types of diabetes: type 1, type 2 and gestational diabetes. Type 1 diabetes is caused by an autoimmune response, in which the immune system "attacks" and destroys the cells that produce insulin. It is not known what triggers this response, but it is believed that genetics plays a role. Usually, but not always, type 1 diabetes develops in childhood or in the teens. People with type 1 diabetes must take insulin to survive (Public Health Agency of Canada, 2003).

People with T2D produce insulin, but the body does not respond to it, or responds poorly to it. T2D usually affects older adults; children and young adults are rarely affected. As with type 1 diabetes, the cause is not clear, but there are several risk factors. Obesity is a very significant risk factor for T2D; eighty percent of Canadian T2D patients are overweight, compared to approximately fifty nine percent of the general population (Tjepkema, 2004). Other risk factors include family history, ethnicity, age and lack of exercise. People with T2D may take insulin, oral anti-diabetic drugs, or a combination of these. Sometimes only a good exercise and diet plan is needed to control blood glucose levels.

Gestational diabetes occurs during pregnancy and generally disappears after parturition (Public Health Agency of Canada, 2003). Gestational diabetes is treated with a diet/exercise/weight management plan and sometimes insulin. Women who have had gestational diabetes are at an increased risk of developing T2D later in life.

Regardless of age or physical condition, diet and exercise along with maintaining a healthy weight are important components of treatment of all types of diabetes (Public Health Agency of Canada, 2003).

1.8.2 Prevalence of diabetes

Prevalence of T2D has been increasing around the globe in recent decades, including the United States (National Diabetes Information Clearinghouse, 2007), Japan (Kitagawa et al., 1994), and Canada (Health Canada, 2006). As well, people have been diagnosed with diabetes at a younger age. It is becoming more common for children to have diabetes (Rosenbloom et al., 1999).

In 2005-2006, 1.9 million Canadians (5% of the population) had diabetes. Approximately 4.5% of Albertans of all ages had diabetes in 2005-2006 (Public Health Agency of Canada, 2008). The prevalence of diabetes is expected to increase throughout Canada to approximately 2.4 million in 2016, with the largest increase expected to be in Alberta, British Columbia, Ontario and the Territories (Ohinmaa et al. 2004).

1.8.3 The cost of diabetes in Canada

Diabetes is very costly to the health care system in Canada. The medical costs incurred by diabetic patients in Canada are approximately three times higher than those without diabetes (Canadian Diabetes Association, 2010).

The costs for medications and supplies for a person with diabetes range from $1000 to $15,000 per year (Canadian Diabetes Association, 2010). The cost to the healthcare system in Canada for diabetes is expected to reach $16.9 billion annually by 2020 (Canadian Diabetes Association, 2010). Clearly, controlling

blood glucose (and therefore reducing the number of diabetic-related costs) would benefit both the patient and the healthcare system.

Hospital stays, physician/clinic visits, surgeries and other necessary procedures are provided by provincial/territorial health care systems. Diabetic drugs may be covered under provincial health care or may be the responsibility of the patient, depending on coverage criteria such as income status (Alberta Employment and Immigration, 2007).

1.9 The PANDA project

The analysis to be completed for this thesis is part of PANDA. Along with the economic model presented here, analysis of nutritional status and physical activity levels of patients living in the Edmonton area are assessed to determine the factors that either help or stop people with T2D from adhering to their health maintenance plans. Specifically, the nutrition/economics branch examines the barriers to dietary adherence by determining patient food consumption patterns with respect to the following:

- Accessibility – affordability
- Availability – level of consistency
- Acceptability – the level to which the food satisfies the consumer's tastes and preferences (ethnic, cultural, personal).

1.10 Thesis Objectives

The main objective of this thesis is to determine the economic and time use factors associated with adherence to an appropriate eating plan for T2D patients. The association between diet and health outcomes, the monetary cost of healthy foods compared to unhealthy foods and the time cost of preparing minimally processed healthier foods will be reviewed to gain knowledge in human behaviour as it relates to food consumption and diabetes. Utility theory, household production theory and the concept of health capital will be reviewed and the following hypotheses will be tested:

H_1: Participants with a higher diet quality measure, compared with lower, will:

- **H_{1a}:** Spend more money on food
- **H_{1b}:** Spend more time preparing food
- **H_{1c}:** Have lower A_{1c} concentrations
- **H_{1d}:** Earn a higher income

H_2: Participants whose households spend more money on healthy food (in this case, fruits and vegetables) will have lower A_{1c} levels than those who spend more money on fast foods, convenience foods, sweetened soft drinks and desserts.

H_3: Participants who spend more time on meal preparation, compared with those who spend less time on meal preparation, will:

- **H_{3a}:** Spend less money on food
- **H_{3b}:** Buy fewer convenience items
- **H_{3c}:** Have lower A_{1c} concentrations

1.11 Thesis organization

This thesis explains some of the possible economic barriers people with T2D experience with adherence to a recommended diet plan. The theoretical framework, literature relating to diet quality measures, diet, health and economic costs and consequences of dietary adherence, is discussed in Chapter 2. Chapter 3 describes methods used in data collection and data entry. The development of the empirical model is described in Chapter 4. Chapter 5 discusses detailed results of the study. This thesis concludes with a summary and interpretation of the results, limitations inherent in the study and areas of future research in Chapter 6.

CHAPTER 2: THEORY AND DIET/HEALTH LITERATURE

2.1 Introduction

In this chapter, consumer theory and utility theory are discussed, using economic analysis and models from literature. Models that explain the association between consumption and gratification are introduced to help illustrate the reasons why people consume goods while being fully aware of adverse consequences. An appropriate measure of diet quality is chosen as an explanatory variable in a health outcomes model.

2.2 Food consumption behaviour

Human food consumption behaviour is complex. Researchers from various disciplines, including psychology (Ogden, 2010), nutrition (Glanz et al., 1998) and economics (Huston and Finke, 2003) have studied the reasons people eat what they eat, why they eat and how much they eat.

How we value food attributes affects the level of satisfaction we derive from consumption. The maintenance of good health through adequate nutrition is only one of the factors determining what (and how much) a person will eat. Therefore, several factors must be considered when developing a model to describe economic and time barriers to a healthy eating plan. Some of these factors are:

- The availability of healthy foods and the relative availability of healthy foods to less healthy foods.
- Time availability for food acquisition and preparation.
- Availability of money for food purchases.
- Culinary skills and nutritional knowledge of the person preparing the meals/snacks.
- Perceived relative importance of health compared to indulgence in unhealthy foods.
- Ethnic and belief considerations (ethical, religious).

2.3 Utility Theory

Utility is defined as the measureable level of satisfaction[1] obtained from consuming a good (Binger and Hoffman, 1998). People consume goods based on desirable attributes of the goods (Lancaster, 1966). Since consumers differ in their preferences for attributes, each consumer derives a different level of utility from consumption of the same good.

It is not possible to make interpersonal comparisons of utility, as it is not objectively comparable (Binger and Hoffman, 1998). One consumer may prefer juicy oranges but obtains no utility from the amount of vitamin C in the orange while another consumer may consume oranges solely because they are a good source of vitamin C and obtains no utility from the juiciness of the orange. Another person may not desire any attributes of the orange and will therefore not consume it.

Utility theory tells us that we choose to consume goods because we believe they benefit us in some way. This is known as positive utility. It is also possible to obtain negative utility from consumption. If, for example, you consume a medicine that tastes bad, the utility derived from the taste of the medicine is negative, as it is delivering the opposite of satisfaction. However, the utility derived from the expected benefits of the medicine compensates for the negative utility from taste, making the product "worth it". Overall, if negative utility is greater than positive utility, you refuse to consume the product.

It is believed that as consumers, we seek to maximize utility, based on preferences, given the constraints of time (24 hours or 1440 minutes/day) and budget (net income). Utility theory states that consumers make consumption decisions resulting in the greatest level of utility with the least investment of time and/or money. This means if two goods give identical utility, the consumer will chose the good with the least cost and/or requires investment of the least amount of non-leisure time. Consumers continually make trade-offs in price, time requirement and desired attributes; the result of this being the highest level of

[1] Utility *per se* is not measureable or observable. We observe outcomes as indicators of utility.

utility the consumer can achieve, given his/her constraints. In other words, every person (or household) maximizes:

$$U(Z_1...Z_m), \tag{1}$$

where *Zi* is the *i*th commodity, *U* is utility (Becker, 1976). We have the following four constraints in household utility maximization, as described by Huston and Finke (2003):

Constraint #1: Consumption technology

$$y_i = \sum_{f=1}^{n} b_{ij} x_j, \tag{2}$$

where *yi* represents the quantity of the *i*th characteristic of the *j*th good (*x*), for all $i = (1, \ldots, r)$ in a system of *r* characteristics and *n* goods and b_{ij} is the consumption technology matrix (Lancaster, 1966), which is the relationship between characteristics and goods. Huston and Finke (2003) use the example of food consumption to illustrate this constraint: A food item (X_j) is translated into its nutritional properties (y_i) and represented by $b_{ij.}$ Foods are chosen based on their nutritional/health-giving properties (y_i), resulting in diet production (Z_1). y_i is input into Z_1

Constraint #2: Commodity production with respect to utility maximization

$$Z_i = f(y_i, t_i(\delta, \theta), k_i), \tag{3}$$

where y_i represents input characteristics into a commodity (Z_i). This requires a production process from goods and services to flow from human capital through

time (t_i). Service also flows from durable goods available (k_i). Another diet and health example from Huston and Finke (2003): requirements of a diet are inputs of nutrition and service flows from capital stock to be able to search for, purchase and prepare meals. Also needed are service flows from durable goods (stove and dishes). Human capital (in this case, personal discount rate (d) and other socio-cultural factors (u)) influences the degree of health improvement from diet. This is believed to affect the influence of time in the equation.

Constraint #3: Budget

$$\sum_{f=1}^{n} p_j x_j(y_i) = wt + V, \tag{4}$$

where x_j is the quantity of good/services j and pj is the price of j, wt is the price of time multiplied by the time and V is income from unearned sources. Income available to purchase goods and services (x_i) is determined by exogenous variables (price of goods, price of personal time and from income from unearned sources).

Constraint #4: Time

$$T = t_w + \sum_{i=1}^{m} t_i \tag{5}$$

This represents one's time in commodity production (t_i) and income generation (t_w) and is always constrained by the time available. The maximum amount of time that can be spent on any activity during a single day is the entire day (1440 minutes).

Consumers will allocate time and money to maximize utility given their unique set of constraints. This can be calculated using the Lagrangian technique.

The consumer who desires good health will demand nutrition, but this demand is a function of the price of goods (in this case, food) and price of his/her time (preparing meals) and income from unearned sources. The equation representing this relationship is:

$$y_i = (p_i, w(\delta\theta), V) \tag{6}$$

The first order condition with respect to time is:

$$\alpha U \frac{\alpha U}{\alpha Z_t} = \frac{\lambda \alpha T_t}{\alpha Z_t} = \frac{\lambda}{\frac{\alpha Z_i}{\alpha T_t}} = \frac{\lambda}{MP_{ti}}$$

where λ is the marginal utility of time.

2.3.1 Health and utility

The choices we make in our daily lives affect our health. Each additional unit of health is obtained with a cost or trade-off. We can choose to eat well, exercise moderately, get enough rest and sleep, avoid/deal with stress and seek medical attention when we are not feeling well. Conversely, we can make choices that contribute to ill health but give us satisfaction (e.g., smoking) with knowledge of the potential health consequences. We often trade off future health outcomes for immediate satisfaction (Huston and Finke 2003).

Utility is affected by health status. Health (freedom from illness and pain) helps us enjoy life to the fullest. Diabetes patients with poorly controlled blood sugar often suffer from ill health. It is therefore assumed that a diabetes patient's utility is affected by blood glucose levels (or A_{1c}), with the highest utility being when the patient maintains A_{1c} levels within the "normal" range.

A_{1c} can be used to estimate utility (specifically related to health) of people with diabetes. An A_{1c} greater than 7.2% is associated with increased risk of co-

morbidities and ill health among persons with diabetes. Maintaining A_{1c} levels below 7.2% is predicted to reduce incidence of blindness, end-stage renal disease, and lower-extremity amputation (Eastman et al., 1997). Small increases in A_{1c} above the normal range can result in poorer health. For people with T2D, a 1% increase in A_{1c} is associated with an 18% increase risk in cardiovascular disease (Selvin et al., 2004). Co-morbidities resulting from poor glucose control could result in lower utility.

Studies have shown an association between utility and health of diabetes patients. Coffey et al (2002) issued Self-Administered Quality of Well Being index (QWB-SA) questionnaires to people with diabetes and created regression models to fit the QWB-SA–derived health utility scores to indicator variables for type 1 and type 2 diabetes and each demographic variable, treatment, and complication. They found that blindness, dialysis, symptomatic neuropathy, foot ulcers, amputation, debilitating stroke, and congestive heart failure were associated with lower utility scores and concluded that major diabetes complications are associated with worse health-related quality of life. In another study, Testa, Simonson and Turner (1998) analyzed measurement properties of outcomes assessment tools. There was an indication from the data of diabetes patients' strong preference for remaining asymptomatic or only having mild symptoms. The results clearly indicated quality of life is affected by differences in glycemic control.

2.4 Discounting

Generally, we assess present costs and consequences of our choices differently than future costs and consequences. People usually have a positive rate of time preference (Drummond et al., 2005), meaning that we would prefer to have the benefit now rather than later. Preference for immediate gratification often leads to time-inconsistent behaviours (O'Donoghue and Rabin, 2000). An example of a time-inconsistent behaviour is stating that you will begin an exercise program in two weeks and making the decision not to begin the program when the time

comes. The general tendency to prefer pleasant experiences as soon as possible and delay unpleasant experiences as long as possible is known as discounting the future (Bradford, 2010). Discounting can be expressed as:

$$P = \sum F_n(1+r)\exp(-n), \tag{7}$$

where P is the present value, F_n is the future value at time n, r is the discount rate and n is time (usually years).

Discount rates differ among individuals. People with a low discount rate for health will value their future health more than an individual with a high discount rate for health.

However, people generally desire good health; health contributes to utility and consumers are willing to invest in it. Therefore it also enters the utility function directly. The state of our health also influences the amount of time that can be spent working for a wage or enjoying certain leisure activities. Lack of health is a source of disutility (Grossman, 1972).

2.5 Health Capital

Health is not exogenous in the Grossman (1972) model, as the level of health is dependent on the resources allocated to it. According to Grossman (1972), we begin our lives with a certain stock of health that depreciates over time. An unhealthy lifestyle can speed the depreciation and investing in health can slow it down. Investments in health capital include own time and investments in market goods such as medical care, diet, exercise, recreation and housing (Grossman, 1972). It is through these investments that we choose how long we will live. When stock of health falls below a critical level, death occurs.

The intertemporal utility function for a consumer can be expressed as:

$$U = U(\phi_0 H_0 ... \phi_n H_n, Z_0 ..., Z_n), \tag{8}$$

where H_o is the inherited stock of health, H_i is the stock of health in the *i*th time period, ϕ_i is the service flow per unit stock, $h_i = \phi_i H_i$ is the total consumption of health services and Z_i is the total consumption of another commodity in the *i*th period (Grossman, 1972).

We may make poor dietary choices (at least, in part) because we are discounting future adverse effects of the foods we eat today in favour of other attributes that contribute to present utility. If we base all our choices in life on maximizing our health and longevity, we would choose a healthy lifestyle and diet; in other words, we will choose to maximize investments in health capital. Since factors besides health are important to us and contribute to utility, we do not always adhere to an appropriate diet plan. One factor that is increasingly important to many of us in modern times is convenience.

2.6 Household production theory and the evolution of modern convenience foods

The household is a consumer. Household consumptive goods include commodities such as food, heating and lighting fuel, clothing, appliances and water. The household is also a producer. Becker (1972) states that households are "small factories", combining capital goods, raw material and labour to clean, feed and produce something useful. According to Becker's Household Production theory, individuals can work for a wage or they can work at home. Working at home does not earn a wage, but does produce consumptive goods. Time spent on the production of goods in the home can be substituted for time earning a market wage or time engaged in leisure activities.

The trade-off between time and money plays a key role in Becker's theory. Leisure time is considered a commodity that can be purchased at the price of the forfeited wage or household production that is not acquired during leisure. An increase in the price of leisure (through an increase in wages) should result in a decrease in demand for leisure and an increase in the demand for the wage workforce.

Before the invention of modern conveniences and inexpensive, convenience meals, there was much demand for household production. Acquisition and preparation of non-convenience foods required a considerable amount of time. Planning and preparing meals and cleaning up after meals were necessary but time-consuming tasks.

2.7 Household production in modern times

Many aspects of our world have changed tremendously over the past fifty years. In the early 1970's, less than 40% of all married women were participating in the work force (Gronau, 1973). In the years following the baby boom, family income rose substantially and family size dropped sharply (Binger and Hoffman, 1998), changing household structure in industrialized countries. Household production became easier and it was possible to work outside the home for a wage and maintain the home through the purchase of newly developed convenience items (Reilly, 1982). This resulted in women joining the work force in unprecedented numbers. In past decades, increasing incomes have lead to higher food intakes in the United States. This has been accompanied by time constraints, time preferences and moderate food prices (Blaylock et al., 1999).

With the widespread use of the microwave oven in the early 1980's and the meals and snacks developed because of it (Mitchell, 1980; Brastad and Beall, 1980), preparing a meal became as easy as taking a package from the freezer and popping it into the microwave for five minutes. Demand for convenience food items rose. We no longer feel we have the time to prepare meals and feel that the time and effort is not worth the bother (de Boer et al., 2004). In the US, between 1977 and 1978, convenience foods were primarily used by employed household managers less than 35 years of age (Capps et al., 1985). Today, convenience foods play an important part in our lives, as people are now valuing time more than people did a generation ago.

The principles that have applied to human consumption decades ago continue to be applicable in modern times. We still invest in health and consume

goods to maximize utility. Income and time are both still constraints to consumption. What has changed over the past few decades is technology. As explained by Lakdawalla and Philipson (2009), technological advancements have increased the cost of physical activity and lowered the cost of food. Instead of being paid to do physical labour in our jobs and in the household, as people did decades ago, we now often pay to exercise (at a health club, pool, exercise or recreation facility), while technology generally provides the energy to perform mundane, physically demanding tasks in the home and in the workplace.

Technological advancements have increased efficiency of performance. The use of computers, calculators and electronic communications has substantially reduced the time and energy required to perform a task. Technology continues to become more widely used, as the benefits, in the form of time and energy savings, outweigh the cost of the technology. However, rather than free up time for more leisure and household activities, we are required to work longer and harder to afford them.

Technology has also lowered the cost of food. Farm mechanization, along with changing farm structure, has increased agricultural crop production in Canada by approximately 60% since the early 1960's (Veeman and Gray, 2009). Increased food production, combined with the increased efficiency of processing, transporting and storing food has resulted in an abundant food supply at a cost that would have been impossible a few decades ago. However, this may have come with consequences that were unforeseeable in the 1970's and 1980's – consequences resulting from the increased demand for convenience. As people work harder and longer at high-stress occupations and engage in technologically driven leisure activities, the demand for time saving and energy saving household items becomes higher and higher.

2.8 Convenience and fast foods

We live in a fast-paced world. There is often little time left for anything after work, commuting, family obligations and extra-curricular activities. As a result,

we may neglect important aspects of our health. For example, sleep is necessary for health and well-being, but is affected by work; there is an inverse relationship between time spent sleeping and both the wage and time spent in the labor market (Biddle and Hamermesh, 1990). Anything that saves time is valuable to consumers today, including time-saving appliances and foods that require very little preparation (convenience foods) or choosing restaurant foods that can be ordered and picked up quickly (fast foods).

The food industry develops thousands of new products every year; many of these are highly processed convenience foods (Nestle, 2002). Convenience foods are generally developed to have reduced preparation time, often made possible by the processor doing much of the preparation (Capps et al., 1985), with processed oils and artificial flavours and aromas. The addition of fillers such as flour, oils, salt and sugar add bulk and flavour with little cost to the producer. But they add fat, simple carbohydrates and sodium to the product.[2] These factors make many of the convenience foods that we eat nearly every day unhealthy choices, particularly for people with certain chronic health conditions.

The growth of the fast food industry in Canada has paralleled the increase in obesity rates in the past couple of decades. From 1982-1997, the money spent on fast food grew at an average annual rate of 6.8% compared to 4.7% for restaurant dining (Jekanowski, 1999). During roughly the same time period (1985-2001), the Canadian obesity rate rose from 5.6% to 14.9% (Government of Alberta, 2010).

Similar findings have been reported in the United States. For example, an association between overweight and self-reported fast food consumption has been reported in the U.S (Martin et al., 2006). Pereira et al. (2005) found a strong association between fast food consumption and obesity in the United States. Bowman et al. (2004) found that an increase in fast food consumption in children and adolescents is associated with a decrease in diet quality.

[2] Simple carbohydrates can raise blood glucose levels.

Chou et al (2003) investigated the factors that could explain why there has been a 50% increase in obesity in the US since the late 1970's. Using data from 1984–1999 Behavioural Risk Factor Surveillance System, they developed an ordinary least squares model to examine the relationship between obesity and factors such as per capita number of restaurants and fast food and grocery store food price. The authors controlled for education level, marital status and household income. The results infer that fast food and full service restaurants are responsible, at least in part, to the increase in obesity. The authors pointed out that the actual underlying cause of the growth in restaurants and restaurant meals may be due in a decrease in non-market time.

2.9 Dietary adherence

Based on the theories of utility and household production, along with the concept of health capital, we can understand the complexity of food consumption behaviour and appreciate that it is not static, but is ever changing and evolving with society. Given the many environmental influences in our society that encourage consumption of high calorie, high fat, high carbohydrate and low nutrient foods, it is little wonder why dietary adherence is a problem for people in all walks of life. Economic pressures, time pressures, personal preferences and social pressures may be factors responsible for following an unhealthy eating plan. We do, however, have the capacity to consciously make healthy choices. It may cost more money and/or time, depending on the choices made, but the benefits, in the form of reduced risk of disease or co-morbidities, may far outweigh those costs.

The nutrition principles that are used as a guide for diabetes patients are basically the same as the general population and include eating a variety of different foods, limiting high fat, high salt and high sugar foods and following a weight maintaining diet plan (Powers, 2003). A proper diet, following nutritional therapy guidelines set by the CDA, can reduce A_{1c} by 1.0%-2%. Table 2-1 describes the CDA nutritional therapy guidelines for diabetes patients.

Table 2-1 CDA Summary of Nutritional Considerations for People with Diabetes

Nutrient	Recommendation
Total carbohydrate	45-60% of total energy intake
Sugars (sucrose)	≤ 10% of total energy intake
Fibre	25-50 grams per day
Fructose	≤ 60 grams added fructose per day
Total fat	< 35% of total energy intake
Saturated Fat	< 7% of total energy intake
Cholesterol	< 300 mg
Polyunsaturated fat	>10% of total energy intake
Protein	15-20% of energy intake
Vitamins and minerals (excluding vitamin D and folate)	Same recommendations as general population. No reason to supplement.
Vitamin D	400IU supplement for people >50 years of age
Folate	400µg supplement of folic acid for women who could become pregnant.[3]

Source: Gougeon et al. (2008)

There is a strong link between blood glucose levels, which are largely influenced by diet in the diabetes patient, and health. A diet high in simple carbohydrates and low in fibre increases the probability of poor blood glucose control in people with diabetes (Wolever et al., 1992) while a diet emphasising high fibre foods has been shown to help diabetes patients maintain target blood glucose levels. It is therefore important for diabetes patients to follow a wholesome diet plan. Factors such as meal planning, grocery shopping, impulse buying and other household members' food choices may influence personal dietary choices and therefore health outcomes. People with diabetes must be careful not only about the food choices they make, but also when to eat, how much to eat and how to prepare their food. Food choices and quantities must be

[3] It was assumed that no women in this study were intending to become pregnant

adjusted to blood glucose test levels, which might fluctuate after exercise, when ill, when traveling or in other situations (Powers, 2003).

2.9.1 Dietary adherence and disease risk

Diet plays an important role in the maintenance of good health. Longevity is linked to dietary patterns (Trichopoulou et al., 1995), as are diseases such as cardiovascular disease, diabetes, obesity and certain cancers (World Health Organization, 2003). Kant et al. (2004) determined risk of mortality based on diet. They used data from the National Health Interview Surveys (NHIS) 1987 and 1992, a stratified multistage area probability sample of U.S. households and a cross-sectional household survey with continuous sampling and in-person interviewing. Respondents were at least 45 years of age and had completed a food frequency questionnaire (FFQ) that contained approximately 60 items. The authors used three approaches to determine mortality risk: 1) a Recommended Foods and Behaviour Score (RFBS), 2) factor scores from factor analysis, and 3) clusters from cluster analysis. The multivariate-adjusted relative risk (RR) of mortality for each of the three types of dietary patterns was examined using Cox Proportional Hazards Regression Analysis. Respondents who left five or more items on the FFQ blank were excluded, as were those with chronic disease, except diabetes and hypertension. The model controlled for race/ethnicity, education level, body mass index, smoking status, supplement use, alcohol use and energy intake. The authors found that dietary patterns characterized by compliance with prevailing food-based dietary guidance were associated with a lower risk of all-cause mortality.

It is well known that health is influenced by diet, and most people are aware of what foods contribute to good health and what foods contribute to ill health. Although health is usually a consideration when making food choices, factors such as taste, convenience and food availability, acceptability and accessibility, may lead to unhealthy eating. Consumers, even those with chronic health conditions, often make unhealthy food choices.

Possible reasons for not adhering to an appropriate diet are many and can change throughout one's lifetime and in changing situations. Children, adolescents and adults may have different reasons for lack of dietary adherence. Neumark-Sztainer et al. (1999) used focus groups of grade seven and grade ten male and female students attending an inner-city school in Minnesota, USA, to determine the factors associated with the adolescent diet. The authors aimed to find the reasons why adolescents choose unhealthy over healthier food choices. Hunger and cravings were reported as the most common reasons for eating what they ate. These adolescent boys and girls stated that a low priority of eating healthily and taste were the most important factors affecting food choices. Convenience and appearance of the food were reported as important considerations as well.

Schlundt et al. (1994) investigated the reasons why adults with T2D do not adhere to their diet plans. The main reasons found were negative emotions, resisting temptation, eating out, feeling deprived, time pressure, tempted to relapse, planning, competing priorities, social events, family support, food refusal and friends' support. A similar study found health beliefs, such as perceived susceptibility to complications; perceived severity and perceived benefits of adherence to a diabetes management plan had a significant effect on adherence for people with diabetes (Wooldridge et al., 1992).

Other studies have reported that time and cost were significant barriers to dietary adherence. Williamson et al. (2000) found that time was a barrier to dietary adherence for diabetic patients in the US. In their survey of 75 diabetes patients, 55 had reported that time constraints interfered with healthy eating, while 9 reported lack of finances. Similar to the findings in this study, other barriers were lifestyle, portion control and denial/unwillingness to make changes.

A study by Cade et al. (1998) from the UK revealed that over half of participants in a diet study reported that following a healthy diet was not difficult. Participants reporting this were found at both high and low dietary adherence scores, as determined by a diet scoring technique. In the same study, perception of

the cost of a healthy diet varied from the highest-scored participants to the lowest, with 29% of the highest scoring participants reporting that it was more expensive to follow a healthy diet, compared to 40% of the lowest-scoring group. 46% of the highest-scoring group also reported that time was a factor in healthy eating. The authors noted that this may not be a good representative sample, as the participants generally had higher incomes and higher education levels than the general population.

It appears that barriers may differ from region to region, with cost being reported as a barrier more frequently in poorer areas than in more affluent areas. For example, cost was the most identified barrier to following a recommended diet by T2D patients in a poor neigbourhood in suburban Virginia, USA (Vigan, et al., 2005).

Time preference applies to food consumption behaviour as it does other behaviours, sometimes resulting in the consumption of foods that may lead to ill health in the future. Huston and Finke (2003) concluded that time preference was a significant factor in determining individual diet quality. They hypothesized that the willingness to subvert future for present utility influences the process of sacrificing time, flavor, convenience and price for a healthful diet.

2.10 Barriers to healthy eating: Constraints

Dietary adherence is often a matter of choice. The consumer may prefer a chocolate bar rather than a fruit salad for dessert with the resources to choose either. However, there are limits to consumption. Our food consumption choices are limited by time (planning, purchasing or harvesting, preparing, consuming) and budget (money available for food) as well as by food availability. These constraints influence consumption decisions. For example, high carbohydrate, high fat convenience foods may be chosen over healthier foods if they are inexpensive and require little or no preparation time. Due to more relaxed constraints, less healthy foods may seem more attractive to consumers, particularly to those with less time or money budgeted for food.

2.10.1 Time constraints: Managing work and leisure

Evidence that time constraints can contribute to stress and ill health has been suggested by Halpern (2005). Halpern (2005) studied health effects of a flexible work policy and found a negative association between a flexible work policy and absenteeism as well as health symptoms of stress. Alberta residents spend more time at paid employment and less time at leisure than residents of any other Canadian province (Human Resources and Skills Development Canada, 2006; Human Resources and Skills Development Canada, 2009). Less leisure time and more work time may mean that Albertans are at a greater risk of stress-related ill health than other Canadians.

Time constraints may result in poor meal planning and less time for meal preparation. This could mean that higher socio-economic consumers may spend less time on self-care activities, assuming that higher income individuals work longer and have more disposable income for recreation and entertainment, leaving little time for self care. Ettner et al. (2009) studied the association between socioeconomic status and time spent on diabetes self-care activities. The authors used Bayesian two-part models to determine the extra time that diabetes patients of different race/ethnicity, education and income spend on these activities while controlling for demographic and clinical characteristics. They found that socioeconomically disadvantaged patients spent more time on self care activities (foot care, shopping/cooking and exercise).

2.10.2 Budget constraints: Food security

The definition of food security is *"a household-level economic and social condition of limited or uncertain access to adequate food"* (USDA, 2008 www.ers.usda.gov/Briefing/FoodSecurity/labels.htm). Food security includes not only getting enough food and preventing nutritional diseases (i.e. food adequacy), but also quality and acceptability.

Budget constraints could contribute to food insecurity and lead to ill health, particularly for people with a chronic condition and are on a very limited budget. Studies have shown an association between low socio-economic status and ill health in diabetes patients, such as more frequent physician visits (Nelson et al., 2001; Bachmann et al., 2003). Balancing household food expenditures, other household costs, health costs, and recreation and entertainment may be difficult for many Canadians.

2.10.2.1 Food costs and food security

In 2008, the average Canadian household spent 10.4% ($7,435) of total expenditure on food (Statistics Canada, 2008). Albertans spent 8.9% of their total household expenditures on food in the same time period. While this is a small percentage of the average household expenditure, there are many Canadians (including Albertans) who find it difficult to provide food for themselves and their families. In 2007-2008, 7.7% of Canadian households were not food secure (Health Canada, 2011). Food insecurity in Alberta, as well as Quebec and Saskatchewan, was significantly lower than the national average (Health Canada, 2011). For food insecure people, providing enough food may mean sacrificing quality, and opting for less expensive energy-dense, nutrient poor foods to satisfy hunger and cravings, rather than meeting micronutrient needs. This may lead to choosing to eat at fast food restaurants instead of full service when dining out, as they offer large portions at relatively low cost.

2.10.2.2 Food Acceptability

Humans expect food consumption to be a positive experience. Acceptability refers to a pleasant taste and freedom from feelings of guilt or adverse reactions. Food preferences begin to develop in infancy and continue to develop throughout life, with new food experiences, changes in social environment and increases in knowledge (Birch, 1998). Factors affecting food acceptability include cultural or religious beliefs, individual food tolerances, exposure to different foods,

information and perceived risks associated with a food and personal preference for sensory and hedonic attributes. Human food choice is limited more by social and psychological barriers than by lack of food attainability (Mela, 1999). Therefore, food acceptability may be one of the most important barriers to following an appropriate diet plan.

Food acceptability is influenced by food neophobia, the fear of consuming a new food. Humans have a natural tendency to seek out new food experiences and at the same time have fear of trying new foods. Foods introduced in infancy or early childhood are likely to be accepted much more readily than those introduced later in life. With this in mind, it is logical to assume that an environment with a greater variety of food choices would result in greater food acceptability and a more diverse diet.

To test the assumption of greater acceptability with more food choices, Flight, Leppard and Cox (2003) administered questionnaires to adolescent students from one metropolitan school and two rural schools in South Australia to determine if socio-economic status and community food environment were associated with food neophobia and willingness to try unfamiliar foods. They found that, while the urban participants had greater familiarity with different foods than did the rural participants, there was only a weak association between food neophobia and socio-economic status within the same community. However, they found a significant association between a combined low socio-economic status and rural area participants and food neophobia. The individuals who had the least exposure to new foods had the greatest food neophobia in this demographic.

2.10.2.3 Food Accessibility

Food may be plentiful and nutritious but be out of reach for some due to budget constraints. The economic situation in the household may play an important role in food choice. Low socio-economic status is strongly associated with a poorer quality diet (Darmon and Drewnowski, 2008). Food costs and physical access to

healthy foods may be significant barriers to following dietary recommendations (Jetter et al., 2008; Horowitz et al., 2004). Monsivais and Drewnowski (2009) found that a higher energy diet was associated with lower nutrient and lower fibre intakes and that a nutrient dense diet was associated with a higher cost. In another study, Kirkpatrick and Tarasuk (2003) used 1996 data conducted by Statistics Canada to determine the relationship between income level and household food expenditures. They found that total food expenditures (including restaurant expenditures) were lower for low-income households than higher income households. Low-income households also purchased fewer servings of fruits and vegetables, dairy products and meat and meat alternates. They concluded that an economic constraint could be a barrier to healthy eating in Canada.

A poor quality diet may lead to obesity, perhaps due to consuming too few servings of (nutrient dense) fruits and vegetables and too many servings of high calorie (energy dense) snack foods. An association between socio-economic status and obesity has been widely reported (Drewnowski and Darmon, 2005; Evans et al., 2000). Darmon et al (2004) used a regression model to determine the relationship between energy density and diet cost at various levels of energy intake and found that energy dense diets were less costly than nutrient-dense, lower-energy diets.

Meyerhoefer and Leibtag (2010) studied the impact of relative prices of low- and high-carbohydrate foods on diabetes patients' medical expenditures. The authors used consumption data from 2000-2005 along with *Neilsen Homescan* price data. The developed a model which included the log of medical expenses (*ME)*, prices (*P)* and income (*Y*). These variables were transformed into log values because they were skewed to the right. The model they developed was:

$$\log ME_{it} = \alpha_m + \delta_t + \sum_h \eta h x_{it} + \sum_K yk \log P_{mt} \exp(k) + B \log Y_{it} + \varepsilon_{it}, \qquad (9)$$

where *k* is food price at different carbohydrate levels, *m* is market area and *x* is all other control variables.

The authors controlled for price, age, ethnicity, gender, education level, household age composition, income per adult equivalent, census region and whether or not the participant lived in a metropolitan area. Data did not include food away from home; it was assumed that food eaten in restaurants did not bias the results. The results showed that the price of high carbohydrate foods was positively associated with both diabetes diagnosis and medical expenditures of diabetes patients in the United States. They also found a positive association between BMI and the price of high carbohydrate foods among women.

Socio-economic status may also influence health and disease risk. Vozoris and Tarasuk (2003) used a multiple logistic regression and data from the 1996/1997 National Population Health Survey to estimate the odds that a randomly selected individual in a household characterized by food insufficiency would report poor health. Individuals in food-insufficient households were more likely to report heart disease, diabetes, high blood pressure and food allergies. Control factors were age group, sex, education level and household income adequacy.

Accessibility may differ among neighbourhoods in the same region. Locally, Smoyer-Tomic, Spence and Amrhein (2006) used city of Edmonton data to determine supermarket accessibility in different neighbourhoods. They tested the hypothesis that inner-city dwellers would have poorer accessibility than outlying neighbourhoods and that supermarket accessibility is greatest in high need areas. They assumed minimum distance from each neighborhood to a supermarket (choosing the closest distance). They calculated accessibility for a particular neighborhood using the population-weighted average distance of all the postal codes within the neighborhood's boundaries. They found that high-need and inner-city neighborhoods had greater supermarket accessibility than other areas in the city. However, six high-need areas had poor accessibility.

2.10.2.4 Food Availability

The maintenance of an appropriate diet is not possible unless healthy foods can be acquired. For some people, healthy foods may be available but out of reach, due to reduced physical mobility, lack of transportation and/or lack of time. Healthy food availability is low if healthy foods are not available at outlets that the consumer can visit with relative convenience (such as in the neighbourhood the consumer lives or works). Therefore, healthy food availability may differ among neighbours, depending on mobility, time constraints and access to transportation.

Some neighbourhoods across North America have greater availability of healthy foods than others. Franco et al. (2009) hypothesized that inadequate availability of healthy foods could be a barrier to following an appropriate diet plan. Food frequency data from subjects living in the Baltimore area were used in this study. A large percentage of black participants were found to have low availability of healthy foods compared to white participants. Income and education were also associated with food availability. Participants living in low healthy food availability census tracts consumed significantly higher amounts of processed meats and saturated fats than those living in high healthy food availability census tracts. They concluded that lack of availability could make healthy eating difficult in some environments, even for consumers motivated to eat well.

Other studies have also focused on food availability in neighbourhoods with different racial, ethnic or socioeconomic compositions. For example, Moore and Diez Roux (2006) examined the associations between food stores/ liquor stores with racial/ethnic composition and socioeconomic composition in three states in eastern America. More than twice as many grocery stores and half as many supermarkets were found in minority and racially mixed neighbourhoods as predominantly White neighbourhoods. Four times as many grocery stores and half as many supermarkets were found in low-income neighbourhoods as high-income neighbourhoods. Also, poorer neighbourhoods were found to have fewer fruit and vegetable markets, bakeries, specialty stores and natural food stores, but more

liquor stores. The authors concluded that the local food environment may contribute to health disparities among neighbourhoods.

Several studies have shown that differences associated with obesity exist in food availability between neighbourhoods in the same or nearby city or town. For example, Zick et al. (2009) used data from Utah and found that, compared to no neighbourhood food outlets, the presence of at least one convenience store, full service restaurant or fast food restaurant was associated with reduced risk of obesity. They also found an association between retail food options and BMI/obesity, varying with income. Multiple food options within a neighborhood reduce BMI/obesity risk, relative to no food options, for all individuals, regardless of income.

Other North American studies reiterate the findings that food availability varies with neighbourhood (Horowitz et al., 2004), and that neighbourhood food availability is associated with differences in resident health outcomes (Inagami et al., 2006; Morland et al., 2006) as well as diet quality (Laraia et al., 2004). Another study found that neighbourhood features that facilitate physical activity are associated with a lower BMI (Zick et al., 2009). However, research conducted in Guatemala by Asfaw (2008) suggests a positive association exists between availability of supermarkets and BMI. Perhaps the association between food outlets and BMI is different between developing countries and the industrialized world.

2.11 The economics of dietary adherence among T2D patients

The results of the research presented in this thesis helps us to better understand the relationship between budget and time constraints and the availability and accessibility of food for T2D patients in Edmonton. People with chronic conditions such as diabetes are particularly vulnerable to ill health if an appropriate diet is not followed. It is therefore necessary to consider food availability, accessibility and acceptability for people with diabetes, as these factors affect food choices.

Time and budget constraints directly affect availability and accessibility of food and therefore influence consumption decisions. If an item you wish to buy is not available locally, you may choose to invest time by traveling to another location to purchase it. The extra time cost increases the total cost of the item. Your consumption choice will then depend on the cost of your time, the utility you expect to derive from the item, the availability and accessibility of close substitutes, and the utility you expect to derive from either of those substitutes. If, on the other hand, an item is available but the price is prohibitive (i.e. not accessible), given your budget constraint and considering other food and non-food consumptive goods, you will simply not purchase the item.

Consumption decisions are also influenced by acceptability. Acceptability affects the level of utility. A food may be available and accessible to you, but if it offers no utility, or offers only a net negative utility, you will choose not to consume it; you may choose a substitute that will cost more money and/or time. Therefore, acceptability may influence both budget and time cost of food.

Acceptability, along with availability and accessibility, are important considerations in diet choices and therefore influence the quality of one's diet. As explained earlier, health is one of many factors affecting utility. Diet quality of an individual will depend partially upon health considerations, but also other food attributes that deliver utility, such as taste, alleviation of hunger and social aspects. These factors are combined to result in food choices that maximize utility, given time and budget constraints. Depending on individual preferences and constraints, the quality of the diet may range from very good to very poor.

2.12 Diet quality measures

Several indices have been developed to determine diet quality. Diet quality indices, as opposed to measures such as Recommended Daily Allowance (RDA) and Recommended Dietary Intakes (RDI), allow for an assessment of the diet as a whole, instead of analysis of isolated nutrients (Drewnowski et al., 2009). Overall diet quality has a stronger association with risk of disease than does individual

nutrients or foods (Kant, 1996). Waijers et al. (2007) reviewed many studies on diet quality indices to determine their effectiveness in assessing overall diet quality and association with disease risk and mortality. They found that existing indices do not predict morbidity or mortality significantly better than individual dietary factors. However, they concluded that it is questionable that it may be impossible to obtain a score that is a much better predictor of health outcomes.

Among the most common diet quality indices are the Healthy Eating Index (HEI), Alternate Healthy Eating Index (AHEI), Recommended Food Score (RFS) and Diet Quality Index (DQI). Variations of diet diversity indices have also been used to model diet quality. Many studies have been conducted to determine a link between diet quality indices and diet-related disease. However, the link between these measures and health outcomes remains challenging for researchers (Drewnowski et al., 2009).

2.12.1 Dietary diversity

Eating a variety of foods from all food groups helps to increase the probability of meeting nutritional requirements. Canada's Food Guide (Health Canada, 2007) recommends that adults consume a daily minimum of the following: 7 servings of fruits and vegetables, 6 servings of grains, 2 servings of meat and meat alternates and 2 servings of dairy products. The positive health outcomes derived from healthy food diversity contribute to utility.

We can model the association between food diversity and a proxy used for health utility. Anderson et al (2007) conducted a literature and web search and a population-based dietary survey to develop an objective, nutrient-based healthy eating indicator shopping basket (HEISB) tool in the UK. Since national food surveys were used as part of the study, the authors were able to identify commonly consumed and culturally acceptable foods. The final tool contained 35 items. Categories developed for the final tool included fruit and vegetable; potato, bread and cereal; fish/meats; dairy; and fatty and sugary foods. They concluded

that the tool could provide a rational basis for examining access and availability of healthy foods in retail and consumer studies.

Drescher (2007) developed a method for determining healthy food diversity in Germany. The basis for the research was previous studies indicating that diverse diets are associated with positive health outcomes. For example, a diverse diet is associated with a lower risk of all-cause mortality (Kant et al., 2004; Kant et al., 2003) and lower risk of cancer (Fernandez et al., 2000; Franceschi et al, 1995; Lucenteforte et al., 2008). The objective of the research of Drescher (2007) was to identify factors that initiate consumers to demand high quality diets and improve willingness to pay for healthy eating.

2.12.2 Dietary diversity and health

The association between dietary diversity and health outcomes has been well documented. Franceschi et al (1995) studied the link between breast cancer and diet diversity. They administered a food frequency questionnaire in Italy between the years 1991 and 1994. The questionnaire asked about consumption of 79 different foods, grouped into 18 food groups. The authors found a positive association between breast cancer incidence and number of servings of bread and cereal dishes, pork and processed meats, and sugar and candies and a negative association between breast cancer incidence and number of servings of milk, poultry, fish, raw vegetables, potatoes and coffee and tea. Also, the variety of vegetables in the diet appeared to have a positive effect beyond that of the benefits of a high vegetable intake, suggesting that diversity itself plays a role in breast cancer prevention.

Similarly, Garavello et al (2008) studied the relationship between diet diversity and the risk of oral or pharyngeal cancer. In this study, diet diversity is defined as the total number of foods consumed at least once per week. Data used for this study was from the Multicentric Case Control Study (1991 and 2005) in Italy. The authors controlled for socio-demographic characteristics, smoking and alcohol consumption habits, anthropometric measures, personal medical history

and family history of cancer. A food frequency questionnaire revealed information about consumption of 78 foods (portion size or frequency of consumption was not recorded). Data were analyzed using multivariate odds ratios. The study suggests that a more diversified diet (especially in fruits and vegetables) reduced the risk of oral and pharyngeal cancer.

Dietary diversity is associated with more general health indicators, such as mortality. Kant et al (1993) compared mortality rates with dietary diversity, based on consumption of foods from five food groups. They administered 24-hour dietary recalls to determine the foods eaten in one day. Each food from a recommended food group (fruit, vegetables, dairy, meat and meat alternates, grains) was assigned one point. Foods excluded from the categories included carbonated drinks, alcoholic beverages, high-fat snacks, candy, coffee and pastries. The analysis controlled for age, income, BMI, supplement use, physical activity, education, blood pressure and cholesterol level. Data were analyzed using Cox's Proportional-Hazards Analysis, from which the association between dietary diversity score (DDS), age at initial interview and other variables contributing to mortality was made, by using the Proportional-Hazards General Linear Model (PHGLM). The inverse diversity-mortality results showed that the relative risk associated with consuming foods from fewer food groups was significantly lower than those who consumed a more diverse diet. The authors concluded that omitting food groups was associated with an increased risk of mortality.

Dietary diversity models

Dietary diversity is associated with positive health outcomes and generally increases with income and wealth (Arimond and Ruel, 2004). Since socioeconomic factors are associated with dietary diversity, it is reasonable to assume that low socioeconomic individuals and households may suffer from poorer health due to lack of dietary diversity, all else being equal. However, dietary diversity may be difficult to assess. Ruel (2002) explains that, although

dietary diversity can be a useful tool to assess diet quality, more research is needed to develop accurate indicators of dietary diversity.

Other models of dietary diversity have been developed and used. A dietary diversity model developed by Maillot et al. (2008) using nutrient profiling, a tool used to rank foods based on nutrient content, to help low socio-economic people consume a more diverse diet. Using data from the nationally representative French INCA (*enquete Individuelle et Nationale sur les Consommations Alimentaires*) survey and its associated food composition and price database, they identified foods with good nutrition for price. They concluded that nutrient profiling can be useful for identifying foods of good nutritional quality.

Dietary diversity models are often used in developing nations. In many countries, such as the Philippines (Kennedy et al., 2007), Burkina Faso (Savy, 2005) and several countries in Africa, Asia and Latin America (Arimand and Ruel, 2004), diet is usually based on staples such as rice with very little of anything else. When food diversity is very low, any increase in diversity will likely result in improved nutritional status. This may be the reason for the strong association between dietary diversity and improved health among low socio-economic status people.

Other studies have indicated that dietary diversity in industrialized nations is associated with obesity (Kennedy, 2004). However, discrepancies in findings exist; some research shows that BMI increases with diversity and others find that dietary variety is associated with a BMI that is more likely to be in the normal range. Kennedy (2004) concluded, based on evidence from dietary components of different people, that perhaps this discrepancy is due to the nature of the foods added (increasing the number of high energy density foods may increase weight and body fat, leading to obesity, while increasing the number of nutrient dense, low-calorie foods, such as fruits and vegetables, may help prevent obesity).

2.12.3 Healthy Eating Index

The Healthy Eating Index (HEI) is a diet quality measure using a 100-point scoring system to determine compliance to recommended dietary guidelines (Hann et al. 2001). The HEI was first developed in America in 1995 and contained ten components. The index was changed in 2005 to reflect the changed dietary guidelines, which included an increase in the emphasis of diet quality aspects (Guenther et al, 2007). Table 2-2 shows components of the HEI (2005).

A Canadian version of the HEI (HEI-C) exists and has been used by Canadian researchers (Woodruff et al., 2008; Shatenstein et al., 2005).

Table 2-2 Healthy Eating Index−2005

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total fruit (includes 100% juice)	5	≥.8 cup equiv. per 1,000 kcal	No fruit
Whole fruit (not juice)	5	≥0.4 cup equiv. per 1,000 kcal	No whole fruit
Total vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No vegetables
Dark green and orange vegetables and legumes	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green or Orange Vegetables and Legumes
Whole grains	5	≥1.5 oz equiv. per 1,000 kcal	No grains
Milk	10	≥1.3 cup equiv. per 1,000 kcal	No milk
Meat and beans	10	≥2.5 oz equiv. per 1,000 kcal	No meat or beans
Oils	10	≥12 grams per 1,000 kcal	No oil
Saturated fat	10	≤7% of energy	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Calories from solid fats, alcoholic beverages and added sugars (SoFAAS)	20	≤20% of energy	≥50% of energy

Source: Guenther et al. (2007)

The results of a study by Weinstein et al. (2004) suggest that HEI could be a useful tool for nutrition and health studies. This study was conducted to determine if HEI could be associated with nutritional biomarkers and to determine the biomarkers most associated with diet quality and healthful food intake patterns. They calculated HEI scores (placed into five categories) and obtained

blood nutrient data from 16,467 adult participants in the National Health and Nutrition Examination Survey (NHANES) III, 1988–94. Using weighted crude and partial Pearson correlation coefficients (*r*) between HEI scores and blood nutrients, they found a positive correlation between HEI scores and serum and red blood cell folate, serum vitamins C and E and all serum carotenoids except lycopene. These blood nutrient concentrations were higher for participants in the highest HEI score group compared with those in the lowest group. Dietary supplement use was associated with a higher HEI score. They concluded that HEI is associated with many blood nutrients. Biomarkers of fruit and vegetable intake showed the strongest association with HEI. HEI was not significantly correlated with several circulating nutrient levels of lycopene, serum ferritin, serum selenium, vitamin D, serum calcium and vitamin A. External factors, such as homeostatic control and sources other than food (e.g. sunlight) help to explain the discrepancy with some nutrients. The authors concluded that HEI may be used to assess diet quality and as a measure of dietary quality in chronic disease studies.

Drewnowski et al (2009) used HEI to determine a link between diet quality measures and health outcomes. Participants (2200 men and 2881women) recorded dietary intake over a 24-hour period prompted by a list of 240 commonly consumed foods and beverages provided by the study team. Analysis of Variance (ANOVA) and regression models revealed no association between HEI and plasma lipid profiles. They found a weak negative association between HEI and BMI and blood pressure in men.

HEI has been used as a tool for determining diet quality of populations. McCabe-Sellers et al. (2007) studied the diet quality of people in the Lower Mississippi Delta (LMD). Using data from a telephone survey of 1699 people from the Foods of our Delta Study 2000, they determined specific interventions needed, and the population subgroups needing special attention. They also compared regional intakes with those of the country. They found that adults in the LMD region had lower HEI scores than the national average (data from NHANES 1999–2000) and that adults in the LMD had a poor diet (HEI score <51), but the

LMD participants whose diets were considered as "needs improvement" (HEI<80) and "good" (HEI ≥80) did not differ from national scores. From these results, the authors concluded that nutrition interventions are needed for low-income adults in the LMD.

Similar studies have shown positive associations between HEI and plasma biomarkers. Hann et al. (2001) found that higher HEI scores were associated with greater dietary variety, higher intakes of fruit and lower intakes of fat. In their sample of 340, 21-80 year old women, higher HEI scores were associated with higher levels of folate, vitamin C fibre and other nutrients. They also found that higher HEI scores were also associated with the participant being older, married, better educated and having a higher income.

2.12.4 Diet Quality Index (DQI) and variants of DQI

DQI was developed by Patterson et al. (1994). The purpose of developing the DQI was to incorporate current dietary guidelines with improved methods of estimating servings and develop and incorporate measures of variety and moderation (Haines et al., 1999). This dietary measure uses a composite of eight food and nutrient variables based recommendations from the 1989 National Academy of Sciences in the United States (Popkin et al.,1996). Patterson et al. (1994) stratified this data into three levels of intake and eight variables for scoring. If a dietary goal was met, the participant was given a score of zero. If not met, but still considered a fair diet, the participant was given a score of one. Two points were given to those who had what was considered a poor diet. When summed over the eight variables, a possible score could be from zero (excellent diet) to 16 (poor diet). A total score of 4 or less was indicative of a good diet, while a score of 10 or more indicated a relatively poor diet (Popkin et al., 1996). The results of their study showed that lower scores (indicating a good diet) were associated with single diet quality measures, such as vitamin C and fibre. From this, they concluded that DQI reflected total diet quality and using single nutrients or foods as diet indicators may result in substantial misclassification.

DQI has been used by researchers to determine diet quality differences among populations and changes in diet quality over time. Popkin et al. (1996) used DQI to determine if dietary differences exist among different racial (Blacks and Whites) and socioeconomic groups (low, medium and high) in the United States. They also determined trends in improving or declining dietary quality over time. The authors used data from 6061 participants in the 1965 Nationwide Food Consumption Surveys, 16,425 in the 1977–1978 Nationwide Food Consumption Surveys, and 9920 in the1989–1991 Continuing Survey of Food Intake by Individuals. They found that diet quality improved for all groups from 1965 to 1989-1991. It was also found that in 1965, Whites of high socioeconomic status followed the least healthful diet (as indicated by higher DQI scores) and Blacks of low socioeconomic status had the most healthful diet.

Diet Quality Index – Revised (DQI-R)

Haines, Seiga-Riz and Popkin revised the original DQI in 1999, resulting in the Diet Quality Index Revised (DQI-R). They expanded the 16-point scale to 100 and reversed the scale (a higher score on the DQI-R scale indicates a *better* quality diet). In contrast to the original DQI measure of eight characteristics, the DQI-R reflects 10 dietary characteristics. The purpose of the revisions to the DQI was to reflect revised dietary guidelines and to incorporate indicators of risk important for young people. Also, diversity and moderation factors were added to directly reflect dietary guidelines.

To evaluate the DQI-R, the authors used data from the 1994 Continuing Survey of Food Intakes by Individuals that included a sample of 3202 adults to evaluate the DQI-R. Participants completed two days of dietary data by using 24-hour recalls, spaced 10 days apart. Data were analyzed by Pearson correlation, ordinary least squares and a nonparametric test to determine trends across groups.

Results showed that the mean DQI-R was 63.4 out of a possible 100 points. 66.9% of participants met guidelines for cholesterol and 59.6% met iron recommendations. Only 19.6% met guidelines for fruit and 23.1% met calcium

intake recommendations. The higher scores showed both qualitative and quantitative improvements (compared to the lower scores) in all components of the DQI-R. The authors believed that the DQI-R should provide an estimate of diet quality relative to national guidelines. Changes in overall diet quality over time can also be assessed by DQI-R.

Newby et al (2003) assessed the reproducibility and validity of the DQI-R using dietary data from 127 men aged 40-75 years. Data included two food frequency questionnaires (FFQs) and two 1-week diet records. DQI-R scores were computed using these data. Diets were assessed separately by each method. Biomarkers were assessed by blood sample.

The authors found a significant positive association between the FFQ scores (reproducibility correlation = 0.72). Correlations between scores for each of the 2 FFQs and diet records were 0.66 (FFQ-1) and 0.72 (FFQ-2). A direct correlation was found between DQI-R scores from FFQ-2 and plasma biochemical measurements of α-carotene (r = 0.43, P < 0.0005), ß-carotene (r = 0.35, P < 0.005), lutein (r = 0.31, P <0.005), and α-tocopherol (r = 0.25, P < 0.05). An inverse relationship was found between DQI-R and plasma total cholesterol (r = -0.22, P < 0.05). With these results, the authors concluded that the DQI-R is reasonably reproducible and valid, although the validity of predicting disease outcomes by this method would require more research.

Diet Quality Index International (DQI-I)

The DQI International (DQI-I) is a diet quality measure that, like many others, uses a scoring system. The components of DQI-I include variety, adequacy (servings of food groups and nutrients), moderation and overall balance (see Table 3-1). This measure was developed for cross-national comparison of diet quality (Kim et al., 2003), but can be used for assessing diet quality of single populations. Since this measure is comparable across nations, it is possible to compare, between nations, areas of strengths and weaknesses in different populations. For example, Kim et al. (2007) found that the typical Chinese diet is

low on variety, presumably due to lower socio-economic status, while the American population tends to score high on variety. In contrast, the Chinese scored high on moderation and Americans scored low on this aspect of diet quality.

Tur et al. (2005) investigated the suitability of the DQI-I to the Mediterranean Diet. Data were collected by administering two 24-hour recalls and a food frequency questionnaire to 1200 (male and female) participants aged 16-65 years. The study was done in the Balearic Islands (Mediterranean) in 1999-2000. Adherence to DQI-I and the Mediterranean Diet were examined and correlations of adherence between the two diets were calculated. Results suggested that the Balearic diet is of poor quality, although several studies have shown that the Mediterranean diet to be of superior quality, as it is associated with reduced risk of cardiovascular disease (Estruch et al., 2006) and increased life expectancy (Trichopoulou et al., 2003). The authors stated that, in spite of the claim of being applicable to diets around the world, the DQI-I measure is not applicable to the Mediterranean diet.

Discrepancies between the Mediterranean Diet and DQI-I existed for alcohol and olive oil consumption guidelines, both of which are important in the Mediterranean Diet but considered as empty calorie foods in DQI-I, adding calories to the diet with no nutritional or health value. However, moderate consumption of alcohol has been associated with reduced risk of cardiovascular disease (Goldfinger, 2003) and olive oil processed in the Mediterranean contains vitamin E and other health-promoting chemical compounds (Owen et al., 2000). A discrepancy also existed with moderation, as dietary fat in the Mediterranean Diet was considered excessive in the DQI-I. The authors suggested that the DQI-I should be modified to better represent the unique dietary patterns of the Mediterranean.

In contrast, Florence et al. (2008) found the DQI-I to be comparable to the HEI in Nova Scotia, Canada. They used both DQI-I and HEI to determine an association between diet quality and academic performance in 5200 grade five

students. Data were analyzed from the 2003 Children's Lifestyle and School-performance Study (CLASS), a large study of health, nutrition, physical activity, school performance, and socioeconomic determinants among grade five students in Nova Scotia, Canada. Data were collected by visiting schools and administering a survey on children's activities and an age-appropriate food frequency questionnaire. Heights and weights were also measured. Mean DQI score was 62.4 and ranged from 26.0-86.0. They found that children in the second and third tertiles were less likely to fail, suggesting that diet quality is associated with academic performance. Results from HEI were similar to DQI-I.

The results from the previous two studies suggest that, although RDAs and AIs for DQI-I are country-specific, perhaps the DQI-I may require further modification to be appropriate for the Mediterranean Diet, but may be appropriate for the Canadian diet, as it is very similar to the American Diet.

CHAPTER 3: METHODS: INSTRUMENTS AND PROCEDURES

3.1 Introduction

This chapter begins with a summary of the data collection process for the dietary adherence branch of the PANDA study (tables and detailed procedures and protocol can be found in appendices), followed by data coding and data entry protocol specific to the economic aspects of dietary adherence. A detailed description of variables and a rationale for each is also included, as well as the rationale and procedure for developing DQI-I, a key variable used as both a dependent and an explanatory variable in the analysis.

Cross-sectional data were collected from June to October, 2009 from T2D patients living in the Edmonton area. 80 participants completed the questionnaire, had a blood sample taken (for A_{1c} measurement) and had anthropometrics completed. Of these, 49 also completed a three-day food record and activity recall, as well as collected and submitted grocery and food receipts. Attention to detail and strict adherence to protocol were needed to ensure effectiveness of the instruments and accuracy of the data.

3.2 Recruitment

Procedures followed throughout this study were in accordance with the ethical standards of the University of Alberta. Recruitment of T2D patient participants for this study began following ethics approval in mid-June, 2009 (ethics approval number: pro00005337). A newspaper article in the Edmonton Journal and a five-minute television presentation were very successful in recruiting participants. Recruitment details are described in Appendix B.

Prospective participants either telephoned or emailed the PANDA team to become involved in the study. Directions to the University of Alberta Agriculture-Forestry building (Appendix C) were given to participants following scheduling of an information session. Included with the directions was a letter describing the inclusion criteria and background information on PANDA. The phone and email

scripts, indicating all inclusion criteria and other relevant information for the participant, can be found in Appendix D.

3.3 Instrument testing and administration

All instruments used in this study were appropriately and thoroughly tested before implementation. This was to help avoid or minimize ambiguity or confusion in the questionnaire, and to estimate time for the participants to complete the required tasks. Test subjects were mostly university student volunteers but also included faculty members and members of the general public.

Figure 3-1 illustrates the data collection process for the nutrition and economics section of PANDA.

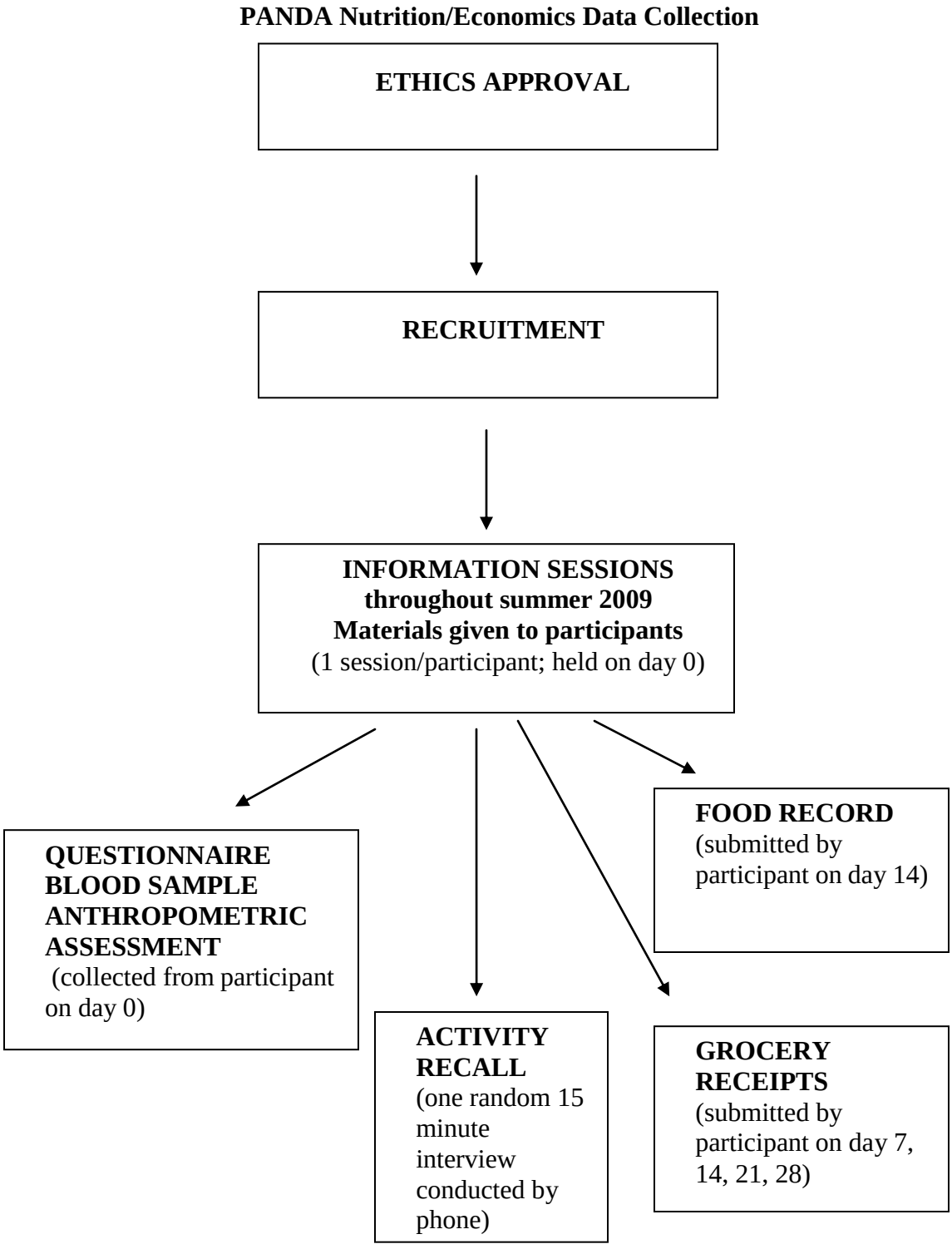


Figure 3-1 Nutrition/Economics Data collection overview

3.3.1 Anthropometric measurements

Weight, height, waist and hip measurements were performed on each participant. Details on measurement technique can be found in Appendix A.

3.3.2 Questionnaire

The questionnaire was developed to gain insight into perceived barriers to dietary adherence. Team members contributed questions relevant to their research area. Many questions were developed from other similar questionnaires (Cohen et al., 2002), and some were developed specifically for our unique group of participants and the data we had required for our analysis. The questionnaire included several questions regarding adherence to Canada's Food Guide and frequency of consuming different foods.

Questions regarding time and money spent on eating, sleeping, exercising, working and other activities were considered when developing the questionnaire. It was also necessary to know what resources the participant perceived were available (or lacking). Household income and number of people living and eating in the home gave information on money available for wants and needs. The food record, anthropometrics, activity recall, grocery and food receipts and the A_{1c} test showed actual results to compliment the perceived (stated) results obtained from the questionnaire.

Responses were coded and codes were transposed onto the questionnaire in Appendix H. Questionnaires were developed with the following considerations:
Length: There were several sections to this study, all contributing a time burden to the participant. The final draft contained 19 pages, after discarding questions deemed unnecessary.
Layout: The questionnaire was geared at the eighth grade reading level to accommodate different comprehension and literacy levels.
Content: The content covered a range of questions from both nutrition and economics disciplines. Our goal was to collect data on participant perceptions of adherence to a diet plan as well as perceptions of constraints. We also required

demographic information, including such data as race, gender, age and household income.

Design: Since consideration was given to the time burden on participants, many questions were designed with a "circle the best answer" instruction. "Circle" or "check" minimized the amount of writing, and therefore time, for the participant to complete the questionnaire.

3.3.3 The information session

The information session was developed and presented to inform participants on how to complete and submit information for the study. We also obtained the questionnaire data, A_{1c} readings and anthropometrics at the session. The script for the PANDA study PowerPoint presentation can be found in Appendix E and contents of the participant package are in Appendices F through N.

The participants were given information about the study and given instructions on how to complete their tasks. Each participant was asked to sign and return one of the two copies of the consent form provided. The second copy of the consent form was for the participant to keep, if desired.

Participants completed the questionnaire at the session. They were also informed about the activity recall to be conducted over the phone at some time during the four-week period. A single blood sample was taken for the A_{1c} reading. Details on the anthropometrics procedure and A_{1c} blood collection can be found in Appendix O. Appendix P contains the template for the identification numbers.

3.3.4 Three-day dietary intake record

The food record was administered to several test subjects to complete over a weekend. From the errors and omissions received, it was determined what to emphasize at the information session.

Participants were asked to complete the food record for three consecutive days on the days specified, including two weekdays and one weekend day. The food record was reported to provide reliable estimates of nutrients (Tremblay et

al., 1983) including caloric intake, protein, vitamins and minerals. Food items and weights of each item were entered into *Food Processor* (*esha* Research, 2006) database.

The completed food records were reviewed for completeness and comprehension. Common omissions included brand name, size of servings (e.g. small, medium or large egg), number of milligrams or IU in supplements, whether potato skin was eaten or not and amount of butter or oil used in recipes. The participant was contacted to obtain any missing information.

3.4 Choosing an appropriate diet quality index

The questionnaire included a section called "Dietary Adherence Questionnaire" containing 12 questions aimed at capturing the participant's perception of adherence to a diet recommended by a doctor, nurse or dietician. Four questions were omitted from the analysis.

The 2008 Canadian Diabetes Association (CDA) makes several nutritional recommendations to diabetes patients (Gougeon et al., 2008). Some of these include: obtaining nutritional counseling by a registered dietician, choosing low-glycemic index foods when possible and obtaining no more than 7% of total energy from saturated fats. Table 3-1 provides a summary of the CDA guidelines.

DQI-I has been chosen as a measure of dietary quality over the CDA guidelines, dietary adherence score from the questionnaire and HEI. The DQI-I score was developed from analysis of the food record data. The food record, Table 3-2 and Table 3-3 provide dietary information and scoring criteria required to calculate a DQI-I score for all participants. DQI-I criteria is more quantifiable than CDA guidelines, scoring different ranges of intake. The food record contains data on all foods eaten within a three-day period, including mass of the food (grams), vitamins, minerals, fibre, fats (total fat, SFA, PUFA), protein and carbohydrates generated from *Food Processor* (*esha* Research, 2006) database. Adherence to RDAs and AIs of nutrients based on Canadian guidelines can be calculated. DQI-I scores were calculated using Table 3-1 and Table 3-2. A perfect diet quality score is 100 and the poorest diet score possible is zero.

Table 3-1 Components of Diet Quality Index-International (DQI-I)

Component	Score	Scoring criteria
Variety	0–20 points	
Overall food group variety (meat/poultry/fish/eggs; dairy/beans; grain; fruit; vegetable)	0–15 points	≥1 serving from each food group/d = 15 Any 1 food group missing/d = 12 Any 2 food groups missing/d = 9 Any 3 food groups missing/d = 6 ≥4 food groups missing/d = 3 None from any food groups = 0
Within-group variety for protein source (meat, poultry, fish, dairy, beans, eggs)	0–5 points	≥3 different sources/d = 5 2 different sources/d = 3 From 1 source/d = 1 None = 0

Table 3-1 Components of Diet Quality Index-International (DQI-I) (continued)

Component	Score	Scoring criteria
Adequacy	0–40 points	
Vegetable group[3, 4]	0–5 points	≥3–5 servings/d = 5, 0 servings/d = 0
		≥100%
		<100–50%
		<50%
Fruit group[3, 4]	0–5 points	≥2–4 servings/d = 5, 0 servings/d = 0
		≥100%
		<100–50%
		<50%
Grain group[3, 4]	0–5 points	≥6–11 servings/d = 5, 0 servings/d = 0
		≥100%
		<100–50%
		<50%
Fiber[3, 4]	0–5 points	≥20–30 g/d = 5, 0 g/d = 0
		≥100%
		<100–50%
		<50%
Protein[3]	0–5 points	≥10% of energy/d = 5, 0% of energy/d = 0
		≥100%
		<100–50%
		<50%
		>10% of total energy/d = 0

Table 3-1 Components of Diet Quality Index-International (DQI-I) (continued)

Component	Score	Scoring criteria
Iron[3, 5]	0–5 points	≥100% RDA (AI)/d = 5, 0% RDA (AI)/d = 0
		≥100%
		<100–50%
		<50%
Calcium[3]	0–5 points	≥100% AI/d = 5, 0% AI/d = 0
		≥100%
		<100–50%
		<50%
Vitamin C[3, 6]	0–5 points	≥100% RDA (RNI)/d = 5, 0% RDA (RNI)/d = 0
		≥100%
		<100–50%
		<50%
Moderation	0–30 points	
Total fat	0–6 points	≤20% of total energy/d = 6
		>20–30% of total energy/d = 3
		>30% of total energy/d = 0
Saturated fat	0–6 points	≤7% of total energy/d = 6
		>7–10% of total energy/d = 3
		>10% of total energy/d = 0
Cholesterol	0–6 points	≤300 mg/d = 6
		>300–400 mg/d = 3
		>400 mg/d = 0
Sodium	0–6 points	≤2400 mg/d = 6
		>2400–3400 mg/d = 3
		>3400 mg/d = 0
Empty calorie foods	0–6 points	≤3% of total energy/d = 6
		>3–10% of total energy/d = 3
		>10% of total energy/d = 0

Table 3-1 Components of Diet Quality Index-International (DQI-I) (continued)

Component	Score	Scoring criteria
Overall balance	0–10 points	
Macronutrient ratio[7] (carbohydrate:protein:fat)	0–6 points	55 ~65:10 ~15:15 ~25 = 6 52 ~68:9 ~16:13 ~27 = 4 50 ~70:8 ~17:12 ~30 = 2 Otherwise = 0
Fatty acid ratio (PUFA:MUFA:SFA)	0–4 points	P/S = 1 ~1.5 and M/S = 1 ~1.5 = 4 Else if P/S = 0.8 ~1.7 and M/S = 0.8 ~1.7 = 2 Otherwise = 0

[1] Values are the percentages of the sample in subcategories.
[2] Abbreviations: RDA, Recommended Dietary Allowance; AI, Adequate Intakes; RNI, Recommended Nutrient Intake; MUFA, monounsaturated fatty acids; SFA, saturated fatty acids; P/S, ratio of PUFA to SFA intake; M/S, ratio of MUFA to SFA intake.
[3] Used as a continuous variable.
[4] Based on 7118 kJ (1700 kcal)/9211 kJ (2200 kcal)/11304 kJ (2700 kcal) diet; 1 kcal = 4.1868 kJ.
[5] Scoring system based on national AI value (see Table 2).
[6] Scoring system based on national RNI (see Table 2).
[7] Ratio of energy from carbohydrate to protein to fat.
Source: Kim et al. (2003)

Table 3-2 Canadian Adequate Intake (AI) values and Recommended Dietary Allowance (RDA) of Nutrients Used to Calculate DQI-I for Adults

Nutrient	RDA or AI	Recommended Value(s)	Source
Iron (Fe)	AI	Males 19+; Females ≥50 = 8 Females 19-49 = 18 mg	Health Canada, 2005a
Calcium (Ca)	AI	0 years = 1000 mg > 50 years = 1200 mg	Health Canada, 2005a
Vitamin C	RDA	Females = 75 mg Males = 90 mg	Health Canada, 2005b

3.4.1 DQI-I versus other diet quality measures

From the review of the literature, it is reasonable to assume that an index that emphasizes primarily variety may be more applicable to developing countries and other nations whose nutritional inadequacies do not include a great deal of overnutrition. The American and Canadian diets, on the other hand, include *excess* food, resulting in obesity. Diversity models may be less applicable to North American diets, as they do not consider the health impact of overconsumption.

For health maintenance and blood glucose control, it is important for people with diabetes to follow a proper diet. Since people with diabetes have, in general, the same nutritional requirements as the general population (Gougeon et al., 2008), it is not surprising that diet quality measures are similar to the 2008 CDA nutritional therapy guidelines. DQI-I is very similar to the CDA nutrition therapy guidelines (Table 2-1 and Table 3-1). One notable difference is a supplement of 400 IU of vitamin D was recommended by the CDA for diabetes patients over 50 years of age but was not recommended by DQI-I.

Referring to Table 2-2 and Table 3-1, it is clear that DQI-I and HEI (2005) are similar. Both indices consider overconsumption of fats, sodium and empty calorie foods and recognize variety as an important component of eating well. Both also consider adequate number of servings of dairy, meat and alternates, fruit, vegetables and grains.

DQI-I and HEI (2005) differ in some respects. DQI-I considers consumption of individual nutrients and fibre, where HEI does not. DQI-I also allows for individual differences in RDAs and AIs, as there are slight national differences with some nutrients.

3.5 Grocery and food receipt collection

Household grocery receipts were used with the assumption that the study participant will, in most cases, consume food purchased by household members.

Percentage of income spent on food was calculated from household grocery receipt data and household income.

Previous studies have tested the validity of using household purchase data to approximate individual consumption. Becker (2001) used individual consumption surveys conducted in Sweden in 1989 to determine the association between household and individual consumption and found very little discrepancy. Similar results were obtained by Lambe et al. (1998), who found that it was possible to use household food purchase data to determine individual consumption. Other studies have shown a strong association between household purchase patterns and individual consumption and have concluded that household food expenditures could be used to proximate consumption (Asfaw, 2008; Martin et al., 2006).

The above examples suggest that household food purchase patterns proximate individual consumption. One exception, however, may be in households with children. Laroche et al (2007) found some discrepancy between individual consumption and household food purchases when some members of the household were children, as frequent refusal to adapt to different dietary habits were found to be common among children of a newly diagnosed family member. Given that this is the only exception and that there were very few households with child members in this study, it is reasonable to assume that 28 days of household grocery data would be a good indicator of food category consumption of T2D patients in Edmonton, Alberta. The information provided by the grocery receipts was purchase data. The food record provided consumption data.

3.5.1 Administration of grocery receipt collection protocol

Participants in this study were asked to submit all household grocery and food receipts in pre-addressed envelopes. Each participant received a one-page instruction sheet that included instructions and several examples of receipts. To

test this tool, we asked several students and staff at the University of Alberta if they understood the instructions.

Participants were to begin collecting all food and drink receipts for a continuous 28 days beginning on the day following the information session. These were to be mailed to the project team at the end of each seven-day period. Receipts were identified with the participant's identification number and each receipt was numbered.

Food purchases were divided into categories and further into subcategories (product). Simple codes were developed for each category and product. Prices were entered, including tax and discounts. Appendix R illustrates the use of data and codes for the grocery receipts.

3.5.2 Categories and products

Food categories reflect food groups and types of foods. Receipt data make it possible to determine if the participant had spent a relatively large amount of money on fruits and vegetables, meat, milk and grain products, and what portion of the total food expenditure was on fast foods, convenience foods and snacks and desserts. Food categories were developed with the following in mind: food group (e.g. dairy, grains, meat and alternates, fruits and vegetables, snacks, sweets); criteria for an appropriate diet (e.g. fat and saturated fat content, sugar content, fibre content); and convenience (e.g. ease of preparation).

Appendix R contains the list of the food categories and products. Table 3-3 includes food categories used for analysis in the study and some common corresponding products.

Table 3-3 Examples of categories and products used to classify grocery receipts

Food category	Products
Desserts	Pies, cakes, cookies, ice-cream
Convenience foods	Frozen pre-cooked meals such as pizzas, *TV dinners* and frozen pasta meals; pre-made sandwiches; pre-cooked meats and other Ready-To-Eat products.
Sweetened soft drinks	Soft drinks such as *Coca-Cola* (does not include sugar-free varieties), sweetened ice tea, *Kool-Aid*, *Tang*, etc.
Fruits and vegetables	Fresh fruit, fresh vegetables, canned fruit, canned vegetables, dried fruit.
Snack foods	Chocolate bars, potato chips, crackers, candies.
Fast foods	Products purchased at fast food chains (*McDonald's, A&W, KFC*, etc.)

Other examples food categories included milk, other dairy, red meats, poultry and breads. Unidentifiable items were coded "not identified" in both the category and product columns. A "not stated" code was used for omitted items (only the total cost of the bill was recorded).

Restaurants were categorized into one of three establishment types (fast food, intermediate and fine dining) to roughly reflect time (assuming fast foods take the least time), cost (assuming fast foods cost the least) and "healthiness" (assuming fast foods are the least healthy or appropriate). All restaurant products were recorded as they appeared on the receipt. Miscellaneous products, coded as "misc", included the following four items: cough drops, care packages, antacids and glucose tablets.

3.6 Activity recall

The activity recall was a fifteen-minute interview with each participant. This was done to determine the time normally spent on activities surrounding food and eating and time spent exercising. We were also interested in diabetes-specific activities. The method used was similar to LaPorte et al. (1979), with the exception that, in this study, the activity was conducted by a single telephone interview, instead of having the participant record activities on paper.

The participant was asked to recall, in chronological order, the activities of the previous day. To help eliminate bias, participants were not to know what day the team member would call for the interview. Although all activities were documented, the focus was on time spent preparing meals and snacks, shopping for food, working and exercising. Also noted was time spent on diabetes-care, such as trips to the drugstore to get diabetes medications. The person who was normally responsible for food preparation in the household (if different from the participant) was interviewed as well. The interview generally took 10-15 minutes. Activity recall details, as well as specific questions used during the phone conversation, can be found in Appendix D. Appendix Q is a sample of an activity recall table.

CHAPTER 4: EMPIRICAL MODELS

4.1 Introduction

The goal of this research is to determine, through analysis of both stated and revealed data, the economic factors influencing dietary adherence of T2D patients.[4] Demographic information and revealed data on household food expenditures, individual food consumption and time use can be combined with stated (perceived) barriers and dietary adherence to achieve this goal. This chapter includes a description of dependent and explanatory variables chosen for analysis as well as a rationale for choosing them. Also included is the development process for the models chosen in the analysis.

4.2 Development of the empirical models

According to utility theory, we assume that people make choices to maximize utility. In this study, participants are assumed to choose the foods and activities that will result in the highest level of utility that they can achieve, given their constraints. The trade-off between health, satisfaction and perhaps guilt, is part of the utility function and is different for everyone. It is assumed that all people desire good health, and that health contributes to utility. Therefore, health is part of the utility function for all participants, although the relative importance of health will be different for everyone. In this study, A1c, a proxy for long-term blood glucose, represents health outcomes. Since high blood glucose over a long period of time is associated with poorer health, A_{1c} is considered a good measure for health outcomes.

As utility differs among individuals, so do constraints. Constraints include budget (or income) and time (1440 minutes or 24 hours). Trade-offs must be made between money spent on food, shelter, clothing, entertainment and other

[4] In this study, dietary adherence refers to adhering to the criteria in Table 3-1: Components of Diet Quality Index-International (DQI-I).

goods and services. As well, time allotted for work, leisure, sleep, volunteering and activities with family and friends must be determined by the individual, who will allocate time and money where utility will be highest, given that there are 1440 minutes in one day and X number of dollars available to be spent.

Just as individuals maximize utility, households maximize utility, given three constraints: budget, household production technology and time available. According to this theory, leisure is considered a commodity.

Recall that utility, as stated in equation (1), is:

$U = U(Z_1 ... Z_m)$,

This function can be applied to households as well as individuals. A household utility function has different inputs and slightly different constraints than an individual utility function. According to Florkowski et al. (1999), the function for household production is as follows:

$U = U(M, H, L)$ is the household utility function, (10)

where U is the household utility function, M is market goods, H is non-market goods and L is leisure. Household utility is made possible by inputs into the household. Market goods and time inputs contribute to household utility. Hence,

$H = H(TH, X)$ is the household production function, (11)

where TH is time allocated to non-market activity and X is a vector of market goods. As with individual utility, household utility is constrained by budget and time. Budget and time constraints can be written as:

$PMM + PxX = WTM + V = I$ is the budget constraint, (12)

where W is the wage rate, TM is time spent working for pay, V is income from other sources, PM is price of market good M and Px is price of market good X, and

$TM + TH + L = TO$ is the time constraint, (13)

where TO is the total time constraint

These equations are versatile and can be modified to apply to many different groups of consumers and in a wide variety of situations and circumstances. The consumers in this study are diabetes patients living in Edmonton. Economic and time use barriers to following a healthy diet will be studied. Basic utility theory and household production theory will be used to develop a set of regression equations that will help explain the reasons why some patients do not adhere to a diet plan. The general utility equation in this study is:

$$\begin{aligned} U &= f(a1c, total, mealprep, dqi, X) \\ s.t. &B, T, HT, \end{aligned} \quad (14)$$

where U is the utility of the participant, *a1c* represents health capital stock, *total* is utility derived from consumption (purchase data) of the foods from the food categories (*fast, frozmeals, popreg, snack, dessert, fv*), *mealprep* represents household production (non-market work represented by meal preparation) and is traded off for other activities constrained by time (*totalleisure, sleeping, timework, timeeat, phys_act*), *dqi* represents investments into health through nutrition (derived from the food record data), X is other factors that contribute to utility but are not discussed in the model, B is the budget constraints (represented by *income*), T is time constraint (1440 minutes), HT is the technology constraint.

People choose certain foods over others because they provide a higher level of utility, whether it is health, satiety, or to satisfy hunger. The foods we choose are limited by willingness to pay (dollar cost of the food and time required) as well as the availability and accessibility of the food.

The results of this analysis are based on the assumptions that the consumer knows the difference between foods that contribute to good health and those that do not and all consumers possess the same level of technology constraint.

4.3 Dependent variables

Dietary adherence is complex and depends on many factors. In order to get a complete picture of the factors affecting dietary adherence among T2D patients, it is necessary to examine factors that affect demand for specific goods. The choice of the dependent variable(s) depend(s) on the question(s) to be answered in the analysis. Table 4-1 indicates the variables used in this analysis, relevance of each variable, and questions to be answered. (Refer to Table 5-1 for a description of all dependent and explanatory variables).

Table 4-1 Dependent variables

Variable	Relevance	Analysis are expected answer the following questions
total	Analysis will reveal factors associated with household food purchases (budget constraint)	What do participants spend their food dollars on? Are daily activities associated with differences in total food costs? Do participants who spend more money on food have a higher quality diet and/or lower A_{1c}?
dqi	Analysis will reveal factors associated with a high quality diet (health capital investment)	Is income and/or education level associated with a diet quality? Are certain time use activities associated with diet quality? Are household food purchase behaviours associated with diet quality?
mealprep	Analysis will reveal factors associated with time preparing meals (time constraint)	Is an increase in activities other than preparing meals associated with a reduction in meal preparation time? Are household food category purchases associated with time preparing meals?
a1c	Analysis will reveal factors associated with health outcomes (health capital stock). The higher the health capital stock, the lower the A_{1c}	Is a higher quality diet associated with a lower A_{1c}? Are household food purchase categories associated with differences in A_{1c}? Are differences in time use activities associated with differences in A_{1c}?

4.4 Explanatory variables

Data were analyzed using correlations and Ordinary Least Squares multivariate regression analysis. All analyses were performed using *STATA 11 Statistical/Data Analysis Special Edition.*

Explanatory variables used for household food category purchases include *fv, frozmeals, snack, popreg, dessert* and *fast*. Other food categories, omitted from this analysis for the sake of simplicity and time constraints, include fine dining, intermediate dining, dairy foods, grains and breads, nuts, and meats.

In the analysis, it was assumed that *fv* was a food category contributing to good health and that *frozmeals, snack, popreg, dessert* and *fast* were food categories contributing to poor health. Fruits and vegetables are known for their health-giving properties and for being nutrient-dense. Diet quality indices, including HDI and DQI, emphasize fruits and vegetables heavily, with high values assigned to consumption, while assigning low or negative values to consumption of many convenience foods, sweetened soft drinks, snack foods, desserts and fast foods. This is mostly due to the high sugar and/or high fat content and low nutritional value of these items. Studies have revealed that fruit and vegetable consumption is the main predictor of diet quality, with high dietary quality positively associated with high consumption (Bowman et al., 2004) and purchases (Cade et al., 1998) of fruits and vegetables. Low dietary quality is associated with fast food consumption (Bowman et al., 2004).

Other variables used in regressions are *age* (or *yearsdiabetes*), *income, sizehhld, eduyrs, female, femwhite, white, antidrug, insulin, all3, dqi* and *bmi*.

4.5 The Models

In order to determine the main factors associated with dietary choice in this study, two models were initially developed for each of the four dependent variables: *total, mealprep, dqi and a1c*. For each dependent variable, one model was used to determine food category expenditure associations and the other to determine time use associations. However, the associations with time use were generally very poor models and were not conclusive. Therefore, all models with time use were dropped from the analysis.

Explanatory variables used for time use factors include *timeeat, mealprep, phys_act, totalleisure, timework, sleeping* and *timelist*. The time spent preparing food for consumption has been associated with reduced total food cost (Burney and Houghton, 2002) and increased diet quality (Larson et al., 2006). Planning and preparing meals are assumed to be positively associated with diet quality and negatively associated with A_{1c}. Time spent working was assumed to compete with

meal planning and preparation, as only a limited time is available in a day, and is therefore assumed to have a negative association with diet quality and a positive association with A_{1c}. Sleeping has been shown to have a U-shaped association with A_{1c} in a previous study by Nakajima et al. (2008), meaning that there is an optimal sleep duration, above and below which is associated with an increase in A_{1c}. The authors explained that A_{1c} rises from a lack of sufficient sleep but confounding factors may be involved with the association between A_{1c} rising due to an increase in sleep above a critical level. In this study, it was assumed that sleep duration is negatively associated with A_{1c} at all levels.

The weak associations and poorly fit models with the time use variables may have resulted from the nature of the data collection: much of the time use data was collected in a 15 minute interview during the summer, which may not have been representative of the activities of the participant in a typical day (see Chapter 6: limitations).

4.5.1 Total household food expenditures (*total*)

Several factors may be combined to explain total household food expenditure. Table 4-2 provides a rationale behind the use of the variables to explain *total*.

Table 4-2 Model development: analysis with *total*

Variable	Expected sign	Rationale
fast, frozmeals, fv, popreg, snack, dessert	+	All categories contribute to total expenditure.
mealprep	-	More time preparing meals is likely associated with less time dining out and fewer purchases of high cost convenience items. The household is spending less *money* at the cost of *time.*
totalleisure	+	If leisure is highly valued, the consumer may trade off time for price. The result would be a higher total food bill.
sleeping	-	Impulsive eating and eating to keep energy up may be minimized by adequate sleep, resulting in a lower food bill.
timelist	-	Planning meals in advance and planning food-shopping trips may significantly reduce food cost.
timework	+	More time working generally means a tighter time constraint. This may result in purchasing more expensive foods to save time in preparing and planning.
bmi	+	People with a higher BMI may eat more and spend more money on food. This would, however, depend of the average BMI of the household.
female	-	Females generally eat less than males and may spend less money on food. This would, however, depend of the gender composition of the household.
income	+	Households with more money to spend on food will spend more money on food (looser budget constraint)
white	-	People of many different backgrounds may be more conscientious of food costs, as the majority may be from countries with higher food costs.
sizehhld	+	More people to feed will likely result in a higher household food cost.
phys_act	+	Physically active people require more calories than sedentary people and will therefore probably spend more money on food.
dqi	+	A healthy diet is believed to cost more than an unhealthy diet (Drewnowski, 2004)

Using utility theory, we assume that consumers invest available dollars in the resources that will maximize utility. The equations that determine total household food expenditures for participants are:

$$\begin{aligned} &total = fast, frozmeals, snack, popreg, dessert, fv, y, \\ &s.t. B \geq p(fast, frozmeals, snack, popreg, dessert, fv, X, HT) + p_y Y \end{aligned} \quad (15)$$

where B is the budget, P is the price of each food category, p_y is the price of good y, y represents all other variables associated with total food expenditure and U is utility.

Based on this framework, utility will be maximized at the lowest possible prices, given consumer preferences. In other words, if two possible purchases result in the same utility but have different dollar prices, the consumer will choose the option that will cost the least. Keeping this in mind, it is assumed that the household will purchase the least costing foods (minimizing *total*) at a given level of utility.

Food category expenditure, as well as time expenditure may be used as predictors of total household expenditure. Model 1 predicts associations between *total* and food category expenditure.

Model 1: Food category expenditure factors associated with total household food expenditure

$$\begin{aligned} total = {} & \beta_0 + \beta_1 fast + \beta_2 fv + \beta_3 frozmeals + \beta_4 snack + \beta_5 popreg + \beta_6 dessert \\ & + \beta_7 bmi - \beta_8 gender + \beta_9 income + \beta_{10} ethnicity + \beta_{11} sizehhld + \beta_{12} phys\_act \\ & - \beta_{13} age + \varepsilon_i \end{aligned}$$

This model is expected to provide information on food expenditure categories in relation to total food expenditure. It is expected that each food category will be positive, as all food expenditure categories contribute to total expenditure. However, the relative impact each category has on total expenditure may be

useful information. This model can also provide insight into the association between income and household food expenditure.

4.5.2 Diet quality index – International (*dqi*)

One of the reasons we choose certain foods over other foods is to acquire health benefits. For example, many people may consume soy beverage instead of cola, even if they prefer the taste of cola to soy beverage, because they believe it will bring health benefits. Using the concept of health capital, we assume that consumers derive utility from being well, and that being ill is a source of disutility. The quality of one's diet (represented by *dqi*) can be used as an example of an investment in health capital. With this in mind, we can model investment in health capital.

Table 4-3 provides a rationale behind the use of the variables to explain *dqi*. Also included is the expected sign for each variable.

Table 4-3 Model development: analysis with *dqi*

Variable	Expected sign	Rationale
fast, frozmeals, popreg, snack, dessert	-	These foods are generally energy-dense and nutrient poor. Consumption of these foods contributes very little to diet quality and can replace more nutritious foods.
fv	+	Diet Quality Index-International places emphasis on consumption of fruits and vegetables.
mealprep	+	More time preparing meals is likely associated with consuming fewer processed foods. This is also probably associated with dining out less often.
timeeat	+	If more time is spent eating, it may indicate the person is not rushed and therefore may be consuming higher quality foods.
totalleisure	-	If leisure time is more valued than household production, it may mean that less time is spent on planning and preparing meals.
sleeping	+	Impulsive eating, and eating to keep energy up may be minimized by adequate sleep, resulting in a higher quality diet.
timelist	+	Planning meals in advance and planning food-shopping trips reduce impulse buying (and therefore eating) of foods with poor nutritional quality.
timework	-	More work time may result in eating fast foods and snack foods or preparing quick meals that usually have reduced nutritional quality.
female	+	Females, regardless of ethnicity, may follow a better quality diet than males.
white	+	Ethnic dishes generally use unprocessed foods that may be of higher nutritional quality.
income	+	Households that have more money to spend on food will have accessibility to higher quality foods than lower income people (Thiele et al., 2003; Beydoun and Wang, 2008).
eduyrs	+	Education is associated with a higher quality diet (Thiele et al., 2003; Beydoun and Wang, 2008).
age	+	Age has been shown to be associated with an increase in diet quality (Thiele et al., 2003)

dqi is an investment in health capital through food. *dqi* contributes to health and is therefore assumed to be a component of utility maximization. Recalling the intertemporal utility function, equation (8):

$$U = U(\phi_0 H_0 ... \phi_n H_n, Z_0 ..., Z_n),$$

Using this equation, we can model the associations between food consumption and health.

Substituting *dqi* into equation (8), we get:

$$U = U(\phi_0 H_0 ... \phi_n dqi_n, X_0 ..., X_n), \tag{16}$$

Substituting food categories and time use variables into this function, we get:

$$\begin{aligned} &dqi = U(\phi fast, \phi frozmeals, \phi snack, \phi popreg, \phi dessert, \phi fv : X), \\ &s.t. B \geq p(fast, frozmeals, snack, dessert, popreg, fv, X, HT) + p_y Y \end{aligned} \tag{17}$$

In this model, *dqi* can be represented by $h_i = \varphi_i H_i$. This implies that consumption of healthy foods enters into the utility function indirectly, as food consumption contributes to health and health contributes to utility.

Since utility maximization is a function of more than maximizing health inputs to achieve maximum health outcomes, differences in *dqi* exist, based on several factors relating to diet and health, such as health discount rate and perceived benefits from eating healthy; other factors not related to health, such as desire/cravings for "unhealthy" foods and personal habits; and constraints.

Model 2: Food category expenditure factors associated with diet quality

$$dqi = \beta_0 - \beta_1 fast + \beta_2 fv - \beta_3 frozmeals - \beta_4 snack - \beta_5 popreg - \beta_6 dessert + \beta_7 gender + \beta_8 income + \beta_9 eduyrs + \beta_{10} age - \beta_{11} ethnicity + \varepsilon_i$$

This model is expected to explain associations between household food category expenditures and diet quality. An unexpected association between food category variables and *dqi* may indicate that household food expenditure categories do not proximate individual consumption patterns. This model can also reveal if participants with a higher diet quality have higher incomes.

4.5.3 Meal preparation time: *mealprep*

Similar to DQI-I, meal preparation is an investment in health capital, assuming that the person preparing the meal is providing and consuming food to obtain nutrients. Table 4-4 provides a rationale behind the use of the variables to explain *mealprep*.

Table 4-4 Model development: analysis with *mealprep*

Variable	Expected sign	Rationale
fast, frozmeals, popreg, snack, dessert	-	These foods are generally convenient. A greater expenditure on these food categories is likely associated with reduced meal preparation time.
fv	+	Fruits and vegetables generally require washing, cutting and peeling as well as cooking. These foods also are often part of a dish or meal that also requires preparation.
totalleisure	-	An increase in leisure time is indicative of the cost of leisure. If a person values leisure highly, it is likely that the person will engage in less market time and/or household production time.
sleeping	+	Lack of adequate sleep may be indicative of time constraints. If time constrained, there may not be much time to prepare meals.
timelist	+	Preparing a grocery list is a factor in household production. The longer the time preparing a list, the more valuable household production, including preparing meals, may be. Also, list preparation may be necessary for meal planning and preparation.
timework	-	Working for a wage often results in greater production than working at home. The more one works for a wage, the less time will likely be spent on household production.
sizehhld	+	More people to prepare meals for probably results in a greater demand for meal preparation and therefore an increase in meal preparation time.
female	+	Females may spend more time preparing meals than males
white	+	Ethnic dishes generally take longer to prepare than North American style cuisine.
income	-	As income rises, the cost of leisure is increased, resulting in a higher time cost of preparing meals.
eduyrs	-	People with more education may spend less time preparing meals.
age	+	Older people likely have more free time, so the time cost of preparing meals may be less than it is for younger people.

Meal preparation is part of household production, contributing to household utility through inputs into health and satiety. The cost of preparing meals is one's time, which is traded off for market time and leisure time. A consumer can choose to follow a healthy diet by choosing healthy meals that are already prepared or by preparing the meals oneself. Therefore, meal preparation time is considered to be a cost and therefore minimized, given preferences and other constraints. The equations that describe factors associated with *mealprep* are:

$$\begin{aligned} &mealprep = f(fast, frozmeals, dessert, popreg, snack, fv, X) \\ &s.t. B \geq (fast, frozmeals, dessert, popreg, snack, fv, X) \; and \end{aligned} \tag{18}$$

where *mealprep* is meal preparation time, *X* is control variables.

Utility is assumed to be maximized at the lowest possible cost (in this case, time cost), given consumer preferences. In other words, if two possible purchases result in the same utility but have different time costs, the consumer will choose the option that will take the least amount of non-leisure time.

Model 3 predicts associations between *mealprep* and food category expenditure.

Model 3: **Food category expenditure factors associated with meal preparation time**

$$mealprep = \beta_0 - \beta_1 fast + \beta_2 fv - \beta_3 frozmeals - \beta_4 snack - \beta_5 popreg - \beta_6 dessert + \beta_7 gender - \beta_8 income - \beta_9 eduyrs + \beta_{10} age - \beta_{11} ethnicity + \beta_{12} sizehhld + \varepsilon_i$$

Meal preparation is one of the largest time consuming activities in household production. This model is expected to provide information on the demographic variables involved in meal preparation time. Income is of particular interest in this regression. This model may also reveal associations between meal preparation and the purchase of convenience foods as well as the purchase of fruits and vegetables.

4.5.4 A_{1c} (*a1c*)

A_{1c} is a measure of health capital stock when used as an explanatory variable. *a1c* used as a dependent variable represents health outcomes. The models developed to explain variation in A_{1c} among individuals were developed assuming that associations exist between health outcomes and diet quality and health outcomes and time use. Table 4-5 describes the variables used in the analysis with A_{1c}.

Table 4-5 Model development: analysis with *a1c*

Variable	Expected sign	Rationale
fast, frozmeals, popreg, snack, dessert	+	These foods are generally high in simple carbohydrates and/or fat and low in fibre. Consumption of these foods may increase A_{1c} by direct consumption as well as by replacing foods that can help to lower/stabilize blood glucose (and A_{1c}).
fv	-	These foods are generally high in fibre and relatively low in simple carbohydrates, contributing to blood glucose (and A_{1c}) stabilization.
totalleisure	-	Leisure time may be indicative of time constraint. If this constraint is looser, spending and eating may be less impulsive. A better quality diet is likely to result in a lower A_{1c}. Also, a less stressful routine may reduce A_{1c}.
sleeping	-	Eating to keep energy up may be minimized by adequate sleep, resulting in fewer low quality foods being eaten. Also, lack of sleep is associated with elevated A_{1c} levels (Nakajima et al., 2008).
mealprep	-	Planning and preparing meals should reduce consumption of highly processed foods that will contribute to a higher A_{1c}.
timework	+	More work time generally means more time constraint. This may result in more stress and less time to plan and prepare foods that contribute to a healthy A_{1c} range.
timeeat	-	Eating quickly may lead to overeating, especially foods that may raise blood glucose.
eduyrs	-	Education level is associated with a higher quality diet (and therefore may help to lower and maintain A_{1c}).

Table 4-5 Model development: analysis with *a1c* (continued)

Variable	Expected sign	Rationale
bmi	+	It was assumed that people with a higher BMI will generally be less healthy than slimmer people, with less controlled blood glucose (and A_{1c}).
female	-	It was assumed that females will be more conscientious of diet than males.
femwhite	-	Since being White and being female is associated with a higher quality diet, it is likely associated with a lower A_{1c} as well.
income	-	Households that have more money to spend on food will spend more money on food (looser budget constraint) and have greater access to healthy foods.
yearsdiabetes	+	It was assumed that the longer a person has had diabetes, the more difficult it is to control $A_{1c.}$
phys_act	-	Physical activity has been shown to help control blood glucose (and therefore A_{1c}).
antidrug, insulin, all3	+	It was assumed that participants on a more aggressive control have had difficulty maintaining blood glucose and may have a higher $A_{1c.}$
dqi	-	A higher quality diet is likely to result in a lower $A_{1c.}$

A_{1c} is a measure of health capital and contributes to utility. The equation representing utility theory and the concept of health capital (equation 8) is:

$$U = U(\phi_0 H_0 ... \phi_n H_n, Z_0 ..., Z_n),$$

Using this equation, we can model the associations between food consumption and health. Substituting relevant variables into the above equation will result in the following:

$$\begin{aligned} &a1c = f(phys\_act, dqi, X) \\ &s.t. B, T, HT \end{aligned} \tag{19}$$

In this model, *a1c* represents health capital, *dqi* is food consumption (an investment in health capital), *phys_act* represents exercise (a time-consuming activity), *X* is other factors that contribute to health outcomes, *B* is the budget constraint (represented by household income), *T* is time constraint (1440 minutes), *HT* is the technology constraint

Using variables from the data available, the following model was developed;

$$\begin{aligned} &a1c = U(\phi_0 H_0, fast, frozmeals, snack, popreg, dessert, fv, X) \\ &s.t. B \geq p(fast, frozmeals, snack, popreg, dessert, fv, X, HT) \\ &+ p_y Y \end{aligned} \tag{20}$$

where *B* is the budget, p is the price of each food category, p_y is the price of good *y*, *X* represents all other variables associated with total food expenditure (or time use), and *U* is utility,

In this model, *Ho* can represent initial A1c. The consumer starts with an initial A_{1c} that can be maintained, improved or "depreciated" over time, depending on choices made.

The consumer does not make all choices based on health outcomes. Therefore, several factors that both raise and lower A_{1c} levels must be considered when modeling health outcomes, based on preferences, health considerations and constraints. Model 4 is stated below. This model predicts associations between A_{1c} and food category expenditure variables.

Model 4: Food category expenditure factors associated with A_{1c}

$$\begin{aligned} &a1c = \beta_0 + \beta_1 fast - \beta_2 fv + \beta_3 frozmeals + \beta_4 dessert + \beta_5 popreg + \beta_6 snack \\ &- \beta_7 phys\_act - \beta_8 antidrug - \beta_9 insulin - \beta_{10} all3 + \beta_{11} yearsdiabetes \\ &- \beta_{12} \log income - \beta_{13} eduyrs + \beta_{14} bmi - \beta_{15} gender - \beta_{16} genrace + \varepsilon_i \end{aligned}$$

A_{1c} is a measure of health outcomes. This model is expected to reveal associations between each of the food categories and A_{1c}. It is expected that fast foods and frozen foods, for example, will be associated with a higher A_{1c} and that fruits and

vegetables will be associated with a lower A_{1c}. Income, education and BMI may also be associated with A_{1c}, revealing differences in demographics.

4.6 OLS assumptions

There are five assumptions that are made when using OLS as an analysis tool. If either of the assumptions is violated, the model may be unreliable. [5] Sign, size and significance reported may not be the true results. The assumptions used in OLS and the tests used in *STATA* are listed below:

The test used to determine the linear in parameters assumption was Ramsey's Regression Specification Error Test (RESET test) – this test determines if non-linear, rather than linear, combinations of the parameters explain changes in the dependent variable. If so, the model may be mis-specified and will require changes. If the model is non-linear, using a log-log, log-linear or linear-log model may correct the specification problem. Also, transforming the data by squaring one or more variables may result in the proper specification.

The test used for the homoskedasticity assumption was the Breusch-Pagan / Cook-Weisberg test - OLS assumes that the error term has a constant variance, regardless of the values of the parameters. If this assumption is violated, there is heteroskedasticity in the regression and it is not BLUE (*Best Linear Unbiased Estimator*). If heteroskedasticity exists, removing the variables responsible could improve the model. Transforming variables may also provide a solution. If the sample is large, robust standard errors may have been used. Unfortunately, the sample in this study was too small to consider using robust standard errors.

No test was performed to determined perfect collinearity. The regression cannot be calculated if two or more variables were perfectly collinear. The fact that a regression was calculated was indicative of no perfect collinearity. However, some collinearity is possible, resulting in unreliable results. During the

[5] For a detailed explanation of the OLS multivariate regression assumptions, see Wooldridge (2006), pages 89-101.

specification process, different models were calculated, omitting variables that could have been collinear (e.g. *female* and *femwhite*)

No tests were performed to determine of the model variables have zero conditional mean (i.e. all explanatory variables are exogenous). As with collinearity, different models were compared to determine if the model revealed predominantly expected sign and magnitude results. Also, goodness of fit was considered when determining the final specification.

The models described in this chapter were developed to determine factors that either help or stop people with T2D from adhering to dietary plans. Total household food expenditures (*total*) and meal preparation time (*mealprep*) are expected to help determine constraints while Diet Quality – International (*dqi*) is expected to give information on inputs into health and A_{1c} (*a1c*) will represent the final health outcome.

Variables in each of the above models were analyzed by comparing several different models. Sign, size and significance of each variable in each model were considered and compared with expected results when developing the final specifications. Goodness of fit was also considered. A small sample size of less than 50 observations limited model specification options.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Introduction

Chapter 5 provides results of the data collected by the process described in Chapter 3, using the analytical methods explained in Chapter 4. This chapter begins with a presentation of preliminary analysis, followed by regression analysis using the final specifications of Models 1 through 4 as well as correlations of relevant variables. Diagnostic tests for functional form and homoskedasticity were performed on each model.

The results of the analysis are provided in Section 5.3, beginning with a correlation table for the variable *total* in Section 5.3.1, followed by Model 1 with the dependent variable *total*. Other dependent variables, discussed in Section 5.3.2, 5.3.3 and 5.3.4, include *dqi*, *mealprep* and *a1c*, respectively. Each model reveals associations between the dependent variable and food category variables, while controlling for several other factors.

5.2 Preliminary analysis

Table 5-1 provides a definition of all variables used in the analysis.

Table 5-1 Variable Definitions

Variable	Type	Description
total	Continuous	Total household food expenditures for 28 days
a1c	Semi-continuous	Participant hemoglobin A_{1c} (proxy for 3 month mean blood sugar)
fast	Continuous	Total household fast food expenditures (all food and drink from fast food chain stores)
frozmeals	Continuous	Total household expenditures on frozen, pre-cooked meals and snacks (meat pies, TV dinners, pizza pops, etc.) for 28 days
snack	Continuous	Total household expenditures on snack foods (candy, chocolate, potato/corn chips, crackers, popcorn, etc.) for 28 days
dessert	Continuous	Total household expenditures on desserts (pies, cookies, cakes and other sweets) for 28 days
popreg	Continuous	Total household expenditures on sweetened beverages for 28 days
fv	Continuous	Total household expenditures on all fruits and vegetables (includes fresh, frozen, dried and canned vegetables; includes potatoes and corn) for 28 days
bmi	Continuous	Participant body mass index: [weight (kg)/height (m^2)]
timeeat	Continuous	Participant total time (minutes) eating in one random 24 hour period
sizehhld	Semi-continuous	Number of people living in participant household (5 = 5+)
female	Dummy	Participant gender (1=female)
white	Dummy	Participant ethnic origin (1=white)
income	Semi-continuous	Total household income (mid-point of $20,000 range)
Diabetes Treatment:		Diabetes treatment variables are compared with diet and exercise alone
antidrug	Dummy	1 = takes antidiabetic drugs
insulin	Dummy	1 = takes insulin
all3	Dummy	1 = takes insulin and antidiabetic drugs
phys_act	Continuous	minutes of physical activity in one random 24 hour period (recalls)
mealprep	Continuous	total meal preparation time for one typical day (from questionnaire)

Table 5-1 Variable Definitions (continued)

Variable	Type	Description
totalleisure	Continuous	total leisure time (minutes) in one random 24 hour period (recalls)
sleeping	Continuous	total minutes sleeping in one random 24 hour period (recalls)
shoptrip	Continuous	time (minutes) for a typical shopping trip, including commuting
timelist	Continuous	total time (min) spent preparing grocery list (household)
dqi	Continuous	Diet Quality Index - International
logincome	Continuous	ln(*income*)
femwhite	Dummy	Gender/ethnicity interaction term
loga1c	Semi-continuous	ln(a_{1c})
logbmi	Continuous	ln(*bmi*)
eduyrs	Continuous	Total years of schooling; assuming: Less than high school = 9 High school completion = 12 Some college/university = 13 College = 14 University graduate = 16 Above = 18
logedu	Semi-continuous	ln(*eduyrs*)
idummy	Dummy	Dummy variable for income (<$60000 annual household income and ≥$60000 annual household income)
workinc	Continuous	Interaction term (*timework*income*)
income2	Continuous	Square of *income*

The questionnaire was designed to provide information on perceived dietary adherence and perceived constraints to adhering to a recommended diet. These data were collected at the beginning of the study from every respondent, and retained whether or not they completed the study. A total of 80 people (respondents) completed the questionnaire. Figure 5-2 illustrates perceived barriers of respondents to following a healthy diet.

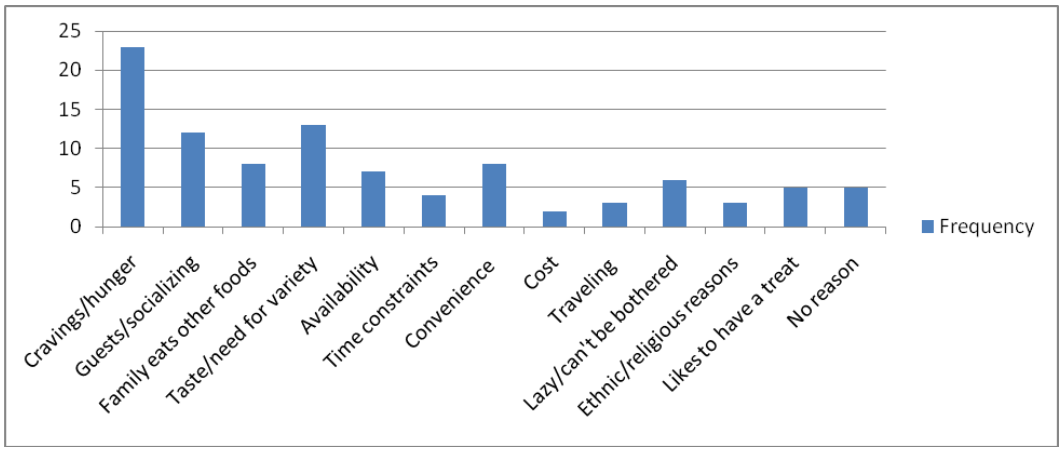


Figure 5-1 Respondent/Participant Perceptions: Barriers to Adhering to Recommended Diet (maximum of 3 per person; 80 respondents) [6]

Figure 5-1 provides information about the perceived barriers that people with T2D experience. As part of the questionnaire, respondents (participants) were asked to report what they perceived to be reasons they ate foods that were not part of their recommended diet. Each respondent could provide up to three reasons.

The main perceived barriers were cravings/hunger (28.75%) and taste/need for variety in the diet. Convenience and availability (low availability of recommended foods and high availability of foods not recommended) also appear to be significant barriers to healthy eating. According to these people, dining and snacking with family and friends negatively affected dietary adherence.

Two people had reported cost as a barrier to adhering to a recommended diet and four had reported time as a factor. However, convenience may also be

[6] A respondent is an individual who had only completed the first step in the data collection process (questionnaire, anthropometric measurements and blood sample). A participant is one who has completed the entire data collection process and hence has provided data for all analysis (but may have omitted some questions from the questionnaire).

important due to time constraints and availability may have been lacking due to cost and/or time constraints (e.g. not enough time and/or money to drive to another neighbourhood store or visit the local Farmer's Market).

Edmonton is not considered a poor Canadian city, as it has a high employment rate and a low tax rate (Edmonton Economic Development Corporation, 2010). There are, however, as in any large city, poorer neighbourhoods and individuals living in poverty. Considering neighbourhood of residence in the analysis may have revealed significant differences in perceived barriers among participants, with participants residing in poorer neighbourhoods perhaps emphasizing cost and/or accessibility constraints more frequently than those from middle- or high-income neighbourhoods. However, household income, which is likely highly correlated with type of neighbourhood and can proxy much of the variability in neighbourhood type, was observed in this study.

Availability, convenience and cost directly affect budget and time barriers to dietary adherence. Other perhaps less obvious factors include taste/cravings, religious and cultural considerations, social environment and other stated reasons described in Figure 5-1. These factors are a part of the utility function (preferences) and do indeed influence constraints as it affects one's willingness to pay for an item. For example, because a person may crave snack foods, it is possible to be willing to pay $90 of a $100 food budget on low quality snack foods, leaving less than an adequate amount for healthy foods for meals. This is an important consideration when determining barriers to healthy eating. However, these considerations were part of another branch of the PANDA study but the results are not discussed in this thesis.

5.3 Comparing beginners and finishers: Respondents and participants

80 respondents were recruited for the study. Of these, 49 completed the study and 31 respondents did not complete the study. For the purpose of this study, a participant is assumed to have completed the study if he/she has submitted all

grocery receipts.[7] Three individuals had completed the food record but failed to complete the grocery receipt collection protocol and were therefore omitted from the participant analysis. Four participants had completed the receipt collection protocol but have not completed the food record (see Table 5-3). Although these participants were included in the analysis, dietary intake data was missing. Therefore, regression analyses that included dietary intake data were automatically omitted. There is no data on the reasons for not completing the study, as respondents were informed that they could leave the study at any time and did not require a reason. Demographic comparisons of the respondents and the participants (completing the study) are shown in Table 5-2.

Table 5-2 Statistical Comparison of Demographic Characteristics of respondents and participants

	Respondents			**Participants**		
Variable	**N**	**Mean**	**Median**	**N**	**Mean**	**Median**
age	31	61.3	61	49	61.5	61
sizehhld	30	2.4	2	49	2.3	2
female	31	.52	1	49	.65	1
eduyrs	31	14	14	49	14	14
income	27	76667	70000	44	67841	70000
white	31	.77	1	49	.84	1
yearsdiabetes	30	7.3	7	48	9.17	6
a1c	31	7.4	7	49	7.3	7

N = number of observations

As indicated in Table 5-2, the median of all variables is the same for participants and respondents (with the exception of *yearsdiabetes*, which was very close). Mean values were also very close in both groups, with the exception of *female* and *income*. Generally, Table 5-2 indicates that, compared with the participants, there was a greater percentage of males not completing the study. As

[7] Some participants had indicated that they did not purchase food during one of the four weeks of the study. There individuals were still included in the study; food cost for the week of no food purchases was zero (not missing data) for that participant.

well, household income among those not completing the study was higher than those completing the study. This discrepancy may have been due to a time constraint for higher income participants, assuming that a higher income is associated with longer working hours.[8] A closer look at the data revealed that 11% of the participants completing the income question (5 participants) indicated a household income of ≥$120,000, while 22% of the respondents completing the income question (6 respondents) indicated a household income of ≥$120,000. However, the median for both participants and respondents was $70,000, indicating the same percentage of lower-income and higher-income participants (assuming that middle-income is approximately $70,000). Based on median values, it appears that there may not be enough difference in any of the demographic variables between participants and respondents to contribute to a significant bias in the results.

The completion of the food record and receipt collection procedure were time-consuming for the participants and required attention to detail. They were also sections of the study that the participant was required to complete on his/her own. Therefore, these sections were more likely to be incomplete than the questionnaire, activity recall or anthropometric assessments. Of the 49 participants completing the study (i.e. completing the receipt collection), four did not complete the food record, or did not complete it properly. Since the food record is an important part of the study, descriptive statistics of participants not completing the food record were isolated for analysis and are shown in Table 5-3.

[8] The association between working time and income is discussed in more detail later in Chapter 5.

Table 5-3 Descriptive statistics of participants failing to complete the food record (N = 4)

Variable	Mean	Median
age	68	67.5
sizehhld	1.5	1.5
female	.75	1
eduyrs	13	13
income	40000	40000
white	1	1
yearsdiabetes	15.25	13
a1c	7.5	7.5

N = number of observations

Table 5-3 indicates that the four participants not completing the food record were older and earned considerably less household income than the average participant (refer to Table 5-2). The household income difference may be due to the fact that the participants failing to complete the food record were older. Older people may, in general, have a more limited attention span and get tired more easily than younger people do and therefore may be unable or unwilling to complete the food record. However, since there were only four participants failing to complete the food record, no concrete conclusions can be made.

5.4 The participants

Descriptive statistics of variables used in the analysis are provided in Table 5-4, with the exception of diabetes treatment variables, which are described in Figure 5-2.

Table 5-4 Descriptive Statistics of participants

Variable	Min	Max	Mean	Median	N
a1c	5.6	10.8	7.26	7.0	49
age	42	84	61.53	61	49
sizehhld	1	5	2.31	2	49
female	0	1	.65	1	49
total	185	1293	614.92	561.24	49
income	≤21000	≥120000	67841	70000	44
yearsdiabetes	.08	35	9.17	6	48
bmi	20.2	73.2	32.29	30.7	49
eduyrs	9	18	14	14	49
white	0	1	.84	1	49
dqi	48.47	83.90	68.11	69.89	45
fast	0	174.46	28.93	13.49	49
frozmeals	0	48.96	11.48	0	49
snack	0	108.47	31.39	26.92	49
dessert	0	63.92	16.52	10.16	49
popreg	0	51.97	5.29	0	49
fv	3.48	258.43	103.02	83.79	49
timeeat	30	155	88.98	90	49
phys_act	0	385	37.45	0	49
mealprep	10	240	111.02	120	49
timework	0	885	201.84	120	49
totalleisure	30	750	283.04	240	49
sleeping	300	1005	508.06	510	49
timelist	0	770	70.71	50	49

N = number of observations

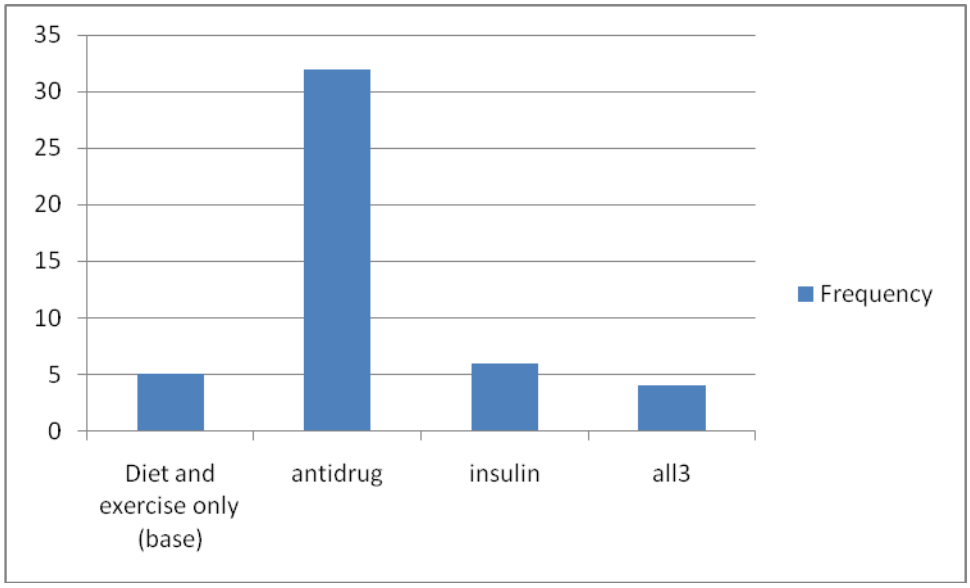


Figure 5-2 Diabetes Treatment

5.5 The analysis: *total, dqi, mealprep* and *a1c*

5.5.1 Total Food Expenditure

Total food expenditure associations were calculated to help determine economic constraints on dietary adherence. Table 5-5 includes correlations between total food expenditures and expenditure categories, demographic variables and time use variables.

Table 5-5 *Total*: Correlation analysis

Variable	Correlation Coefficient	Significance
age	**-0.33**	**0.0205**
bmi	0.06	0.6674
income	**0.58**	**0.0000**
sizehhld	**0.56**	**0.0000**
female	-.08	0.5950
timework	**.38**	**.0066**
white	0.12	0.4180
fast	**0.41**	**0.0032**
fv	**0.46**	**0.001**
popreg	0.26	0.0675
frozmeals	**0.61**	**0.0000**
snack	**0.45**	**0.0013**
dessert	**0.33**	**0.0221**
dqi	**-.40**	**.0066**
timelist	-.07	0.6315
sleeping	**-0.33**	**0.0190**
totalleisure	-.17	0.2336
phys_act	0.12	0.4052
mealprep	0.09	0.5529
timeeat	0.06	0.6862
Significant variables (at 5% level of significance) in **bold** type		

Many of the correlation results were as expected. *total* was significantly and positively correlated with all food categories except *popreg*. Perhaps due to very few purchases of sweetened beverages, *popreg* was not significantly correlated with total food expenditure. Not surprisingly, *income* and *sizehhld* were significantly and positively correlated with *total*, suggesting that households with more income and households with more people spend more money on food. *Age* was negatively correlated with total food expenditure, perhaps because older people have smaller households or fewer people eating at their homes. Also, older people generally eat less than younger people. A correlation between *age* and *sizehhld* reveals that older people in the sample did indeed have smaller

households: age is negatively and significantly associated with household size (correlation coefficient: -.36; significance: .0113)

The results from the correlations showed that time use variables are not significantly associated with total food expenditure. One variable, *sleeping*, was negatively and significantly correlated with *total* at the 5% level of significance.

dqi was negatively associated with *total*. It was assumed that a higher quality diet costs more than a lower quality diet, although it may not necessarily cost more to follow a higher quality diet.

A large component of *dqi* is fruit and vegetable consumption. However, *fv* was positively correlated with *total.* Since fruit and vegetables contribute to total food expenditure, the positive correlation was expected. Other factors important in *dqi* are vitamin and mineral consumption in foods and supplements, empty calorie food consumption (these foods reduce the *dqi* score) and moderation in fats, sugars and salt. When considering all factors contributing to *dqi* score, it is possible to obtain a positive association between *fv* (a large part of the *dqi* score) and *total* while obtaining a negative association between *dqi* and *total*.

***Total*: regression analysis**

Correlations indicate associations between variables. Regression analysis controls for confounding factors that may be present in the correlation analysis. The variable *total* was used as the dependent variable for Model indicating associations between food category variables and total food expenditure.

The following variables were removed from the original specification in Model 1: *bmi*, *snack*, *popreg*, *female* and *sizehhld*. Table 5-6 shows the regression results for Model 1. Results of specifications tests for Model 1 are presented in Table 5-7.

Table 5-6 Model 1: Food category factors associated with total household food expenditure

Variable	Coefficient	Standard error	Significance
Intercept	-135.43	262.2556	.609
fast	1.38	.9393	.150
fv	**1.45**	**.4914**	**.006**
frozmeals	**6.90**	**1.8124**	**.001**
dessert	3.16	1.8247	.093
income	**.002**	**.00103**	**.030**
white	15.93	76.0206	.835
phys_act	.074	.4200	.860
age	3.25	3.7616	.393
timework	.30	.1669	.084
R^2 = **.75** Adjusted R^2 = **.68** Number of observations = **44** Significant variables (at 5% level of significance) in **bold** type			

Table 5-7 Model 1 assumptions test results

Name of Test	Result	Interpretation
Ramsey RESET test	F(3, 27) = 1.13 Prob>F = .3530	Correct functional form
Breusch-Pagan / Cook-Weisberg test	X^2 = 2.24 Prob>X^2 = .1346	Constant variance of error terms

The results of the Ramsey RESET test indicate that, for Model 1, there are no problems with functional form a. Also, the Breusch-Pagan/ Cook-Weisberg test revealed no heteroskedasticity.

Along with food category variables, the following explanatory variables were used in Model 1: *age*, *income*, *white* and *phys_act*. It was assumed that people who are more physically active might eat more food (and therefore spend more money on food) than those who are sedentary, all other things being equal.

Model 1 explains 75% of the variation in total food expenditure. Significant and positive associations (at 5% level) were found between the food categories *frozmeals* and *fv* and the dependent variable *total*. Also significant was the variable *income*. These variables were also positive and significantly

correlated with total. The coefficient on *frozmeals* is 6.90, indicating that, along with the $1 total expenditure with each $1on *frozmeals*, there is another $5.90 expenditure in other food categories not included in the regression. These food categories may be complementary to convenience meals. Similarly, a $1 increase in fruit and vegetable expenditure will increase total food expenditure by $1. However, there is another $0.45 associated with a $1 increase in *fv*, indicating that an increase in fruit and vegetable purchases is associated with an increase in expenditures in other food categories.

In general, the regression analysis also indicates that diabetes patients in Edmonton with higher incomes spend slightly more money on food than those with lower incomes. It also appears that patients who spend more money on frozen meals and fruits and vegetables spend more money on food in general than those who spend less on these items.

Other variables in the regression were not significant (*phys_act, age* and *white*). *Sizehhld* was removed from the regression in the final specification, as it was found to be very insignificant.

The analysis with *total* suggest that diabetes patients living in Edmonton who spend more money on frozen convenience foods and fruits and vegetables spent more on their total food expenditures than those who spend less on these foods. This may mean that those who purchase more of these items purchase more of other food items than those who spend less on these items. Perhaps this is an indication that people who purchase (and consume) more fruits and vegetables (perhaps because they are not energy dense) as well as convenience foods (they are generally energy dense but perhaps not satisfying) generally consume more food and therefore may spend more money on food.

5.5.2 Diet Quality Index – International (DQI-I)

In this study, *dqi* was used as a dependent variable in multivariate regression analysis to determine associations between diet quality and food category purchases and between diet quality and time use factors. Correlations between *dqi*

and time use variables helps to determine if eating healthy requires a higher time cost than not eating healthy. Correlations between *dqi* and food category expenditure variables give further insight into the monetary cost of eating well and build on the results of analysis with *total.* Table 5-8 provides correlation results of variables with *dqi.*

Table 5-8 *Dqi:* Correlation analysis (n = 49)

Variable	**Coefficient**	**Significance**
timeeat	-.03	.867
phys_act	.16	.287
mealprep	.20	.20
timework	**-.38**	**.011**
totalleisure	-.08	.614
sleeping	.15	.336
timelist	-.10	.519
fast	**-.52**	**0.0002**
fv	**0.38**	**0.0098**
popreg	0.02	0.8977
frozmeals	**-.48**	**0.0010**
snack	-.17	0.2586
dessert	-.03	0.8441
total	**-.40**	**.0066**
age	**.31**	**.0379**
eduyrs	.09	.5471
white	-.21	.1637
income	**-.41**	**.0091**
femwhite	-.07	.6466
female	-.06	.7190
Significant variables (at 5% level of significance) in **bold** type		

fast and *frozmeals* were negative and significantly correlated with *dqi*, while *fv* was positive and significantly correlated with *dqi* (at the 5% level of significance). DQI-I places strong emphasis on fruit and vegetable consumption, so this result was expected. The negative correlation between *dqi* and *fast* and *dqi* and *frozmeals* may be due to the lower quality of these food categories replacing higher quality options such as lean meats, whole grains, low-fat dairy and fruits and vegetables and/or the reduced score from consuming "empty-calorie" foods

(See Table 3-1). The positive correlation between *age* and *dqi* was expected, as it was assumed that older people follow a better quality diet than younger people.

The negative correlation between *income* and *dqi* was unexpected. It was believed that people with higher incomes have better accessibility to higher quality foods and therefore follow a better quality diet than lower income people. However, this may indicate that people who are working longer and getting a higher income are sacrificing healthy meals for time. The negative correlation between *timework* and *dqi* seems to re-iterate this suggestion: the more time a participant spent working the lower the DQI-I score.

timework was the only significant time use variable. The correlation coefficient between *dqi* and timework was negative, suggesting that diabetes patients who spend more time working have a lower quality diet. This was an expected association.

It was hypothesized that participants who spent more time preparing foods would eat fewer convenience and fast foods and would therefore have a better quality diet than those who did not, so it was expected that *mealprep* would be negatively correlated with *dqi*. However, the data was collected during the summer, when participants may have been less likely to prepare meals (see Chapter 6: limitations).

Another surprising result is the negative correlation between *dqi* and *total*. It appears that higher total food expenditure is associated with a lower quality diet. This may be because, although fast foods and convenience foods may be inexpensive on a cost/calorie basis, these foods may be more expensive on a cost/serving basis. There may also be confounding factors in the correlations. Multivariate regression analyses help to determine the associations between food expenditure categories and *dqi* and time use variables and *dqi*, while controlling for factors that may be confounding.

***Dqi*: regression analysis**

Model 2 was developed to help determine associations with food category variables and diet quality. The variable *dqi* was used as the dependent variable for Model 2.

The following variables were removed from the original specification: *snack, popreg, female* and *white*. Since *timework* was significantly correlated with *dqi,* it was tested for specification but was not significant and was obviously not appropriate for the model. Table 5-9 shows results from regression analysis for Model 2. Table 5-10 shows results of assumptions tests.

Table 5-9 Model 2: Food category expenditure factors associated with diet quality

Variable	Coefficient	Standard error	Significance
Intercept	**69.10**	**10.6407**	**.000**
fast	-.064	.03515	.079
fv	**.065**	**.0169**	**.001**
frozmeals	**-.16**	**.06809**	**.030**
dessert	-.086	.06517	.196
age	.037	.1218	.766
income	**-7.64×10^{-5}**	**3.59×10^{-5}**	**.041**
eduyrs	.029	.4952	.954
R^2 = **.61** Adjusted R^2 = **.53** n = 40 Significant variables (at 5% level of significance) in **bold** type			

Table 5-10 Model 2 assumptions test results

Name of Test	Result	Interpretation
Ramsey RESET test	F(3, 27) = .55 Prob>F = .6526	Correct functional form
Breusch-Pagan / Cook-Weisberg test	X^2 = .49 Prob>X^2 = .4854	Constant variance of error terms

For Model 2, the results of the Ramsey RESET test and the Breusch-Pagan / Cook-Weisberg test indicate correct functional form and no heteroskedasticity, respectively.

The analysis from Model 2 suggest that a $1/month increase in household fruit and vegetable expenditure is associated with a .065 point increase in DQI-I score, a $1/month increase in convenience food expenditure is associated with a .16 point decrease in DQI-I score and a $1 increase in annual household income is associated with a $7.64x10^{-5}$ point decrease in DQI-I score.

Some similarities among the correlations and regressions are worth noting: *fv* was positively correlated with *dqi* and was positive and significant in the regression analysis; *frozmeals* was negatively associated with *dqi* in both correlation and regression analysis. These results were expected.

People are generally aware of the reduced nutritional quality of fast foods and convenience meals, but the reason why people habitually choose these lower quality foods is not well understood. Socio-economic constraints can contribute to a reduced diet quality (Beydoun and Wang, 2008). However, the results shown in Model 2 indicate a *negative* and significant association between diet quality and income at the 5% level. As well, the correlation between *dqi* and *income* is negative and significant, suggesting that a higher income is associated with a reduced quality diet. Perhaps there is an inverted U-shaped association between diet quality and income (increasing up to a point and then decreasing again). This unexpected result coincides with the unexpected findings from associations between *dqi* and *total*, as it was expected that a higher quality diet would cost more than a lower quality diet. In this study, it appears that those spending less on food and earning less income have a higher quality diet. To test the suspicion of an inverted U-shaped curve, *dqi* was plotted with *income* and a fitted line was generated, as shown in Figure 5-3.

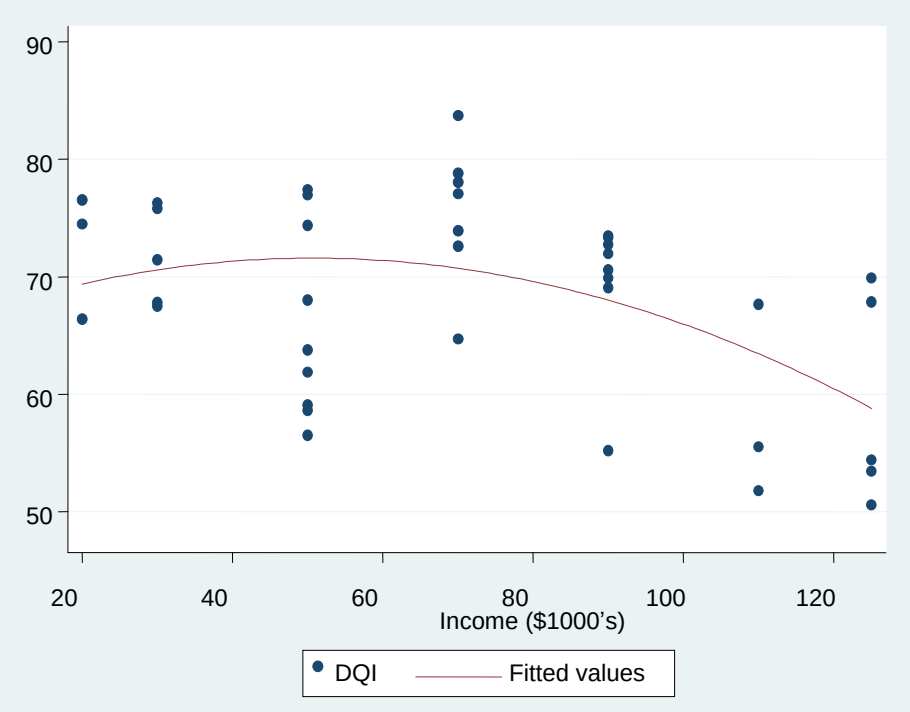


Figure 5-3 DQI-I and Income

Figure 5-3 indicates an inverted U-shaped association between *dqi* and *income*. Therefore, an increase in income for low-income participants may result in a higher diet quality, while an increase in income for high-income participants may result in a lower diet quality. These figures show that the participants with the highest diet quality were those at the middle-income level (approximately $60,000 annual household income).

To further test the association between income and diet quality, a regression model with the explanatory variables *income* and *income2* were regressed on *dqi* and is shown in Model 5.

Model 5: Association between diet quality and income and square of income

$$dqi = \beta_0 + \beta_1 income + \beta_2 income2 + \varepsilon$$

Table 5-11 shows the results of the regression with *dqi* as the dependent variable and using *income* and *income2* as explanatory variables. This reveals the shape and nature of the curve: a positive and significant coefficient on *income2* would indicate a U-shaped association; a negative and significant association would indicate an inverted U-shaped association and a non-significant association would indicate no association.

Table 5-11 Regression test for shape of the association between diet quality and square of income

Variable	**Coefficient**	**Standard error**	**Significance**
Intercept	65.61	5.900	.000
income	2.35×10^{-4}	1.78×10^{-4}	.195
income2	-2.32×10^{-9}	1.19×10^{-9}	.058
R^2 = **.24** Adjusted R^2 = **.20** n = 40			

The results of the regression showed a positive but not significant association between *dqi* and *income* and a negative and significant association between *dqi* and *income2* (The p-value was .058 and is not significant at the 5% level of significance. However, the small sample size, along with how close the p-value was to .05 was taken into consideration). This further indicates an inverted U-shaped association between diet quality and income. The variable *income* was not significant, indicating that the linear association between income and DQI-I is not significantly different from zero.

A possible reason for the result with diet quality associations and income may be confounding factors with time use. It is generally assumed that planning and preparing good quality meals takes time, whether preparing meals using wholesome, minimally processed ingredients instead of using pre-packaged, highly processed convenience foods, or dining out in a full service restaurant instead of eating at a fast food restaurant. The correlation coefficient between *dqi* and *mealprep* was not significant at the 5% level. *timework* was negative and

significantly correlated with *dqi*, indicating that an increase in time spent working was associated with a lower quality diet.

The variable *timework* was used to test whether or not time use was associated with variations in DQI-I. From the inverted U-shaped association found between *dqi* and *income*, the negative correlation between *timework* and *dqi* and the insignificant linear regression result with *dqi* as the dependent variable and *timework* as an explanatory variable, it was predicted that time spent working was a factor for dietary adherence among the higher-income participants and not significant among the lower-income participants.

Model 6 was developed to perform the Chow test, to determine if the lower-income participants exhibited different behaviour with respect to diet quality and work time than higher-income participants. The significant covariates from Model 2 were used, with the addition of *timework* and using *idummy* as a dummy variable for income range (<$60,000 and ≥$60,000). An interaction term *workinc* (*timework***income*) was added. Model 6 is shown below, followed by the regression results in Table 5-12 and the results of the Chow test in Table 5-13.

Model 6: Regression analysis for determining association between time spent working and DQI-I: Set-up for Chow Test

$$dqi = \beta_0 - \beta_1 fast + \beta_2 fv - \beta_3 frozmeals - \beta_4 dessert + \beta_5 age + \beta_6 eduyrs - \beta_7 timework + \beta_8 idummy + \beta_9 workinc + \varepsilon_i$$

Table 5-12 Model 6: Working time and income association with diet quality

Variable	Coefficient	Standard error	Significance
Intercept	**69.11**	**12.8186**	**.000**
fast	**-.09**	**.0383**	**.027**
fv	**.05**	**.0206**	**.014**
frozmeals	**-.14**	**.0794**	**.094**
dessert	-.09	.0718	.239
age	7.32×10^{-3}	.1600	.964
timework	4.71×10^{-4}	8.46×10^{-3}	.956
eduyrs	-.047	.5535	.933
idummy	.17	3.3273	.959
workinc	5.16×10^{-3}	.01083	.637
R^2 = **.57** Adjusted R^2 = **.43** n = 40 Significant variables (at 5% level of significance) in **bold** type			

Table 5-13 Model 6 Chow test results

Explanatory variable	Dummy variable	Interaction term	Result	Interpretation
timework	*idummy*	*workinc*	F(1, 30) Prob>F = .9595	Reject null hypothesis: Higher and lower income participants exhibited different eating behaviour with respect to working time

The Chow test result indicates that participants in the lower-income (<$60,000) group behaved differently than those in the middle- and higher-income group (≥60,000) with respect to time spent working and diet quality. From the result from the Chow test and the inverted U-shaped association between DQI-I and income, as shown in Figure 5-3, it was assumed that patients who spent more time working were more time time-constrained, negatively affecting diet quality. The regression analysis results in Table 5-14 and Table 5-15 further suggest that time may be a constraint to dietary adherence among high-income diabetes patients.

Table 5-14 Working time and food category variables association with diet quality of participants with annual income <$60000

Variable	Coefficient	Standard error	Significance
Intercept	**68.46**	**4.7234**	**.000**
fast	-.13	.09687	.204
fv	.026	.04604	.579
timework	$4.94x10^{-4}$	.01004	.962
R^2 = **.15** Adjusted R^2 = **-.04** n = 17 Significant variables (at 10% level of significance) in **bold** type[9]			

Table 5-15 Working time and food category variables association with diet quality of participants with annual income ≥$60000

Variable	Coefficient	Standard error	Significance
Intercept	**69.81**	**3.8504**	**.000**
fast	**-.093**	**.03586**	**.018**
fv	**.037**	**.02020**	**.083**
timework	**-.011**	**$6.47x10^{-3}$**	**.093**
R^2 = **.60** Adjusted R^2 = **-.54** n = 23 Significant variables (at 10% level of significance) in **bold** type			

It is clear from Table 5-14 that for participants with annual household income below $60,000, working time was not a factor in diet quality. This model is a very poor fit (R^2 = .15), in contrast to Table 5-15, which shows an R^2 of .60. Table 5-15 indicates that for participants with annual household income of at least $60000, time spent working was negatively associated with diet quality. For these participants, a $1 increase in annual income was associated with a reduction in DQI-I of .011 points. This suggests that time may be a factor in dietary adherence among middle- and high-income diabetes patients, but not for low-income patients. Clearly, there is a difference in behaviour between the two income groups with respect to working time and dietary adherence.

[9] The significance level was increased to the 10% level for this analysis as the sample size is very small

5.5.3 Meal Preparation time

To further examine relationships between time constraints and dietary adherence, correlations between *mealprep* and food category variables, time use variables, and other relevant variables were calculated. Results are shown in Table 5-16.

Table 5-16 *Mealprep*: correlation analysis

Variable	Correlation Coefficient	Significance
total	.09	.5529
frozmeals	-.21	.1451
fast	**-.28**	**.0474**
snack	-.10	.5019
dessert	.14	.3526
popreg	.09	.5533
fv	**.33**	**.0193**
timeeat	**.33**	**.0193**
timelist	.11	.4371
timework	-.11	.4526
totalleisure	-.08	.5968
sleeping	-.17	.2309
phys_act	.26	.0734
a1c	-.06	.6673
dqi	.20	.20
sizehhld	.27	.0577
income	.04	.7787
age	.11	.4675
female	-.26	.0728
white	-.16	.2593
eduyrs	.09	.5530
Significant variables (at 5% level of significance) in **bold** type		

Table 5-16 indicates that *fv* and *timeeat* are significant and positively correlated with *mealprep* and *fast* is significant and negatively correlated with *mealprep*. These results suggest that diabetes patient households who spend more time preparing meals spend more time eating, spend less money on fast foods and more money on fruits and vegetables. No other food category variables or time use variables were significant at the 5% level. *a1c* and *dqi* were not significantly correlated with *mealprep*.

The p-value for *sizehhld* was .0577, only slightly higher than the 5% significance level determined as the cut-off for interpretation in this study. Given the small sample size, *sizehhld* was interpreted as being significantly correlated with *mealprep*, meaning that more time is spent preparing meals in households with more people. *age, female, white* and *eduyrs* were not significantly associated with meal preparation time, suggesting that meal preparation time is not statistically different among different demographics.

***Mealprep*: regression analysis**

The variable *mealprep* was used as the dependent variable for Model 3 and indicates associations with food category variables and diet quality. The final specification for Model 3 is found in Table 5-17.

The following variables were removed from the original specification: *popreg, snack, dessert, age, white* and *income*. Model 3 was tested for correctness of functional form and for homoskedasticity. This is presented in Table 5-18.

Table 5-17 Model 3: Food category expenditure associations with meal preparation time

Variable	Coefficient	Standard error	Significance
Intercept	**123.30**	**48.5950**	**.015**
fast	-.35	.1897	.074
frozmeals	**-1.11**	**.4693**	**.022**
fv	.1485	.1134	.198
female	-21.40	13.3707	.117
sizehhld	**22.03**	**3.4336**	**.393**
eduyrs	-2.97	3.4336	.393
R^2 = **.38** Adjusted R^2 = **.29** Number of observations = **49** Significant variables (at 5% level of significance) in **bold** type			

Table 5-18 Model 3 assumptions test results

Name of Test	Result	Interpretation
Ramsey RESET test	F(3, 27) = 2.27 Prob>F = .0955	Possibility of incorrect functional form
Breusch-Pagan / Cook-Weisberg test	X^2 = 0.00 Prob>X^2 = .9921	Constant variance of error terms

For Model 3, the results of the Ramsey RESET test and the Breusch-Pagan / Cook-Weisberg test indicate a possibility of incorrect functional form and no heteroskedasticity, respectively.

***Mealprep*: regression results**

In Model 3, regression analysis indicates than none of the food category variables were significant at the 5% level. The regression model is a poor one, as the fit is .38 and the adjusted R^2 is .29. This suggests that the relationship between food category expenditures and time preparing meals is weak at best for T2D patients living in Edmonton.

The regression analysis for variables significant at the 5% level of significance shows that a $1 increase in fast food expenditure is associated with a .47 minute decrease in meal preparation time and a $1 increase in convenience meals expenditure is associated with a 1.11 minute reduction in meal preparation time. Also significant was *sizehhld*: A one-person increase in household size is associated with a 22.03 minute increase in meal preparation time. Fruit and vegetable expenditure and fast food expenditure were not significantly associated with meal preparation time. Gender, income and education were also not associated with meal preparation time.

5.5.4 Hemoglobin A_{1c}

A_{1c} is a proxy for long-term (three month average) blood glucose levels for diabetes patients and was used as the health outcomes measure for analysis of the data. Analysis with *a1c* is expected to provide information on the variables

associated with health outcomes of diabetes patients. Table 5-19 indicates correlations between relevant variables and *a1c*.

Table 5-19 *A1c:* Correlation analysis (n=49)

Variable	Correlation	Significance
total	.057	.695
frozmeals	.161	.269
dessert	-.055	.706
fast	**.372**	**.008**
snack	.177	.225
popreg	.162	.267
fv	**-.430**	**.002**
dqi	**-.383**	**.009**
income	.012	.940
logincome	-.0042	.9785
timeeat	.141	.333
sleeping	.032	.826
phys_act	-.001	.992
timework	**.287**	**.046**
totalleisure	-.131	.370
shoptrip	-.206	.165
timelist	-.078	.593
mealprep	-.071	.626
bmi	.056	.704
yearsdiabetes	.06	.6884
antidrug	**.33**	**.0219**
insulin	.20	.1747
all3	**.43**	**.0029**
female	.04	.8049
white	-.0098	.9468
femwhite	-.15	.3151
eduyrs	-.07	.6480
Significant variables (at 5% level of significance) in **bold** type		

As expected, the variable *fast* was positive and significantly correlated with *a1c* and *fv* was negative and significantly correlated with *a1c.* These correlations suggest that an increase in fast food purchases (assuming that purchases proxy consumption) is associated with an increase in A_{1c} and an increase in fruit and vegetable purchases is associated with a decrease in A_{1c}. No other food category

was significantly correlated with *a1c*. *dqi* was significant and negatively correlated with *a1c*, suggesting that a high quality diet is a factor in maintaining a lower A_{1c} for diabetic patients. This may also suggest that DQI-I is a suitable indicator of diet quality for adults with diabetes.

timework was positive and significantly correlated with *a1c*, suggesting that working too long may lead to poorer health outcomes. A possible reason why extra time working is associated with a higher A_{1c} is the possibility of time constraint causing the patient to purchase food and eat on impulse or lack of time to eat a proper meal between shifts. The high stress of working long hours may be another possible explanation for the association between *timework* and *a1c*. Other time use variables were not significantly correlated with A_{1c}.

Two of the three diabetes treatment variables (*antidrug* and *all3)* were positive and significantly correlated with *a1c*, while *insulin* was positive but not significant at the 5% level of significance. A possible explanation for this unexpected result is that perhaps diabetes patients on aggressive treatment have poorer control over blood glucose than those who rely on diet and exercise alone for treatment. Another possible explanation may be that patients on aggressive control may be less aware and/or less motivated to adhere to diet and exercise regimes, resulting in poorly controlled blood glucose over time.

A1c: regression results

The variable *a1c* was used as the dependent variable for Model 4. Model 4 indicates associations with food category variables and A_{1c}.

Many studies have shown a linear relationship between A_{1c} and co-morbidities (Stratton et al. (2000); Gilmer et al. (2005); Selvin et al., 2004, Khaw et al., 2004). In contrast, Meyerhoefer and Leibtag (2010) found that elasticities were appropriately used to determine the association between medical expenditures and the prices of high carbohydrate foods (A_{1c} is associated with co-morbidities in diabetes patients and is therefore associated with medical expenses). However, specification of the model in this study showed that a linear

model resulted in a poor model. A log-linear model was chosen for associations between food category expenditures and A_{1c}. The chosen model indicates percentage change in A_{1c} from a one-point increase in the dependent variables. This model shows the most plausible results. Results of the analysis with food category expenditures and *loga1c* are presented in Table 5-20 and the assumptions test results are presented in Table 5-21.

Table 5-20 Model 4: Food category expenditure associations with *loga1c*

Variable	Coefficient	Standard error	Significance
Intercept	**1.87**	**.1126**	**.000**
fast	8.83×10^{-4}	5.58×10^{-4}	.124
fv	$\mathbf{-7.18 \times 10^{-4}}$	$\mathbf{2.80 \times 10^{-4}}$	**.015**
frozmeals	1.31×10^{-3}	1.05×10^{-3}	.221
popreg	2.24×10^{-3}	1.60×10^{-3}	.169
phys_act	-1.56×10^{-4}	2.27×10^{-4}	.496
antidrug	.10	.05129	.066
insulin	.10	.06283	.131
all3	.042	.09727	.670
income	-4.25×10^{-7}	6.10×10^{-7}	.491
eduyrs	3.74×10^{-3}	7.83×10^{-3}	.636
R^2 = **.59** Adjusted R^2 = **.46** Number of observations = **42** Significant variables (at 5% level of significance) in **bold** type			

Table 5-21 Model 4 assumptions test results

Name of Test	Result	Interpretation
Ramsey RESET test	F(3, 27) = 1.42 Prob>F = .2585	Correct functional form
Breusch-Pagan / Cook-Weisberg test	X^2 = 1.15 Prob>X^2 = .2830	Constant variance of error terms

The results of the Ramsey RESET and test Breusch-Pagan / Cook-Weisberg test revealed correct functional form and no heteroskedasticity, respectively.

The variables in Model 4 explain 59% of the variation in *loga1c*. The regression results indicate that a $1 increase in household fruit and vegetable

expenditure is associated with a $7.18x10^{-4}$% reduction in $A_{1c.}$ No other variables were significantly associated with *loga1c* at the 5% level of significance in the regression analysis.

Diabetes treatment variables (*antidrug*, *insulin* and *all3)* were not significantly associated with A_{1c}, compared with using lifestyle treatment alone. Previous studies have reported mixed results with aggressive treatment to control A_{1c} or co-morbidities strongly associated with poor glycemic control. Gray et al. (2000) found that greater intensity of treatment/ aggressive glucose control reduced length of hospital stay but did not significantly reduce number of events or mortality rate, compared with conventional and less aggressive treatment. A similar study (Palmer et al., 2000) found that intensive control with metformin reduced number of events and improved survival in T2D patients in the UK.

5.6 Summary: total, dqi, mealprep and a1c

Many of the results of the analysis of this study revealed expected results. Expected outcomes that were observed in this study were:

- Patients with higher incomes spent more money on food.
- A_{1c} was negatively associated with diet quality.
- Meal preparation time was negatively associated with convenience and fast food purchases.

Some unexpected results were:

- An inverted U-shaped relationship was observed with diet quality and income.
- Meal preparation time was not associated with A_{1c}, diet quality or total food expenditure.
- Although time use variables were not found to be significant, the correlation results showed some association between *dqi* and *timework* and *a1c* and *timework*.
- *timework* was not associated with diet quality among low-income participants, but was negatively associated with diet quality among higher income participants.

CHAPTER 6: SUMMARY, CONCLUSIONS AND LIMITATIONS

6.1 Introduction

The relevance of the results is discussed in this chapter and is compared with results from similar studies. Similar findings are noted and discrepancies are discussed. Biases that may be present in the data are also discussed. This chapter includes a recap of the hypotheses and shows whether or not each hypothesis was determined to be correct. Possible discrepancies between the hypotheses and the conclusions are discussed. This chapter concludes with policy implications and possible areas of future research.

6.2 Income and time factors associated with a healthy diet

Eating well requires knowledge; you must know what foods and combinations of foods provide adequate nutrition as well as where to access, and how to prepare, nutritious foods. Eating well also has a cost; both time and money must be invested to obtain nutritious foods. But does a higher quality diet cost more than a lower quality diet for T2D patients in Edmonton? The results of this study suggest that following a healthy eating plan and obtaining better health outcomes does not necessarily cost more than following a less appropriate diet.

Studies have suggested that a healthy diet costs more than a less healthy diet (Cade et al., 1999; Drewnowski, 2004). However, other studies have found that it does not necessarily cost more to follow a nutritious diet. Bernstein et al. (2010) concluded that, in the US, significant dietary improvements are possible without an increase in food costs, especially if beans, whole grains and nuts are emphasized rather than red meats. They also pointed out that 40% of American annual food expenditure is on meals outside the home, which are more expensive than meals prepared at home. Reducing the number of meals purchased outside the home may result in lower food expenditure. Other researchers have reported similar findings (Raynor et al., 2002; Beydoun et al., 2008). Burney and Houghton (2002) found that participants enrolled in a nutrition and education

program improved dietary quality and reduced the cost of their food. This suggests that knowledge and skill may play a significant role in dietary adherence as well as food expenditure.

The present study, however, shows no significant association between diet quality and meal preparation time or total food expenditure and meal preparation time. Meal preparation time may have been shown to be significant if data were collected in another season (see Chapter 6: limitations).

Diet quality was negatively correlated with total food expenditure. However, further analysis indicated an inverted U-shaped association. It makes sense for diet quality to improve with income, as the budget constraint is not as tight at higher levels. It appears that this is only true up to approximately middle-income level in Edmonton ($60,000 annual household income). This may indicate that budget is a constraint for healthy food purchases in Edmonton for people earning less than average income. However, as income rises above a critical level, perhaps to a point where consumers do not feel constrained by income and feel they can purchase food without considering budget, diet quality peaks and then decreases. The reason for this appears to be a switch from budget constraint to time constraint at approximately $60,000 income.

Time spent working was negatively correlated with diet quality and positively correlated with A_{1c}, perhaps suggesting a time/budget trade-off. The desire to work longer to earn more money may mean sacrificing a good quality diet as well as good health.

Correlation analysis between time spent working and income is positive and significant (correlation coefficient .47; significance level .0013). This indicates that people who work longer hours have a higher income than those who work fewer hours. DQI-I was negative and significantly correlated with time spent working, perhaps indicating a time constraint. Further analysis using the Chow test indicated that lower-income participants had behaved differently with respect to working time and diet quality compared with middle- and higher-income participants. Regression analysis, separating the two income groups

indicated different behaviour between the groups, with working time negatively associated with diet quality among the middle- and high-income participants and not significantly associated with diet quality among the lower-income participants. From these results, it appears that budget constraint could be a barrier to dietary adherence for low-income participants only and time constraint could be a barrier to healthy eating for high-income participants.

6.3 Diet, income and time factors associated with A_{1c}

Diabetes patients sometimes have a target A_{1c} within the normal range, but often slightly higher. An A_{1c} of less than 7% is a reasonable goal for many, but not all, diabetes patients (Qaseem et al., 2007). A wide deviation from this range may contribute to diabetes co-morbidities. One of the goals of *medical nutrition therapy for diabetes* includes maintaining blood glucose as close to the normal level as the patient can safely achieve (Franz et al., 2002).

The results of this study indicated a negative and significant association between A_{1c} and diet quality, both with regression analysis and correlation. From this, it was concluded that the guidelines for healthy eating, as illustrated in Table 3-1 (Components of DQI-I scoring system), are reasonably appropriate for diabetes patients, as these guidelines appear to help patients maintain a healthy A_{1c} level. Since DQI-I is negatively associated with total food expenditures, it was also concluded that food cost may not necessarily be a barrier to healthy eating for diabetes patients (it is not necessary to spend more money to adhere to a healthy diet plan). The results of the analysis coincide with the perceived barriers obtained from the questionnaire: only two respondents (out of 80) reported cost as a barrier to healthy eating.

6.4 Conclusions

Analysis of the data provided information to answer the hypotheses stated in Objectives. Data were analyzed using OLS and correlation analysis to determine

the relationships between diet quality, health outcomes, food cost and time cost for people with T2D living in Edmonton. The following conclusions were made:

H_1: Participants with a higher Diet Quality Index International (DQI-I) score spend significantly *less* money on food, do not spend significantly more time preparing food, have lower A_{1c} levels and earn a lower income than those with a lower DQI-I score.

H_2: Participants whose households spend more money on healthy food have lower A_{1c} levels than those who spend more money on fast foods, convenience foods, sweetened soft drinks and desserts.

H_3: Participants who spend more time on meal preparation do not spend significantly more money on food, do buy fewer convenience food items, do not have significantly lower A_{1c} levels and do not have a significantly different DQI-I scores than those who spend more time on meal preparation.

6.5 Limitations

Several possible biases and limitations were inherent in this study. While these limitations and may affect the quality of the results, overall, the data collected are expected to provide a reasonably accurate assessment of the economic and time use constraints of people with T2D in Edmonton. Proper procedures and strict adherence to protocol helped to ensure that the data obtained were representative. Limitations to the study are described below.

Pilot study

This thesis was part of a pilot study. As described in the Methods section, instruments and procedures were developed and pre-tested. The study was a test in itself, as this was the first time to implement the instruments used. However, the results obtained from this study are not preliminary; strict adherence to

protocol and accurate and precise data collection and analysis ensures that the results are valid.

Diabetes and diet quality measures

DQI-I, used as a measure of diet quality in this study, is not diabetes-specific. Different outcomes may have been possible if a diabetes-specific index was used. However, the principles of healthy eating are basically the same for people with diabetes as those without diabetes (Powers, 2003). Therefore, it was assumed that only a minimal discrepancy exists between DQI-I and a diabetes-specific diet quality score.

Factors other than diet affecting A_{1c}

The effect of different foods and environmental factors on A_{1c} levels is complex and not completely understood. Combinations of foods affect the rate at which glucose enters the blood. Studies have suggested that a negative association exists between fibre consumption and blood glucose and/or A_{1c} (Anderson et al., 1991; Giacco et al., 2000; Chandalia et al., 2000). While fibre is an important component of DQI-I, a diabetes-specific diet quality index may have emphasized fibre more than DQI-I.

Researchers have also found that low-moderate alcohol consumption may have a lowering effect on fasting glucose and A_{1c} of people with diabetes (Shai et al., 2007; Turner et al., 2001). Other researchers have found a positive association between caffeine consumption and blood glucose (Johnston et al., 2003; Robinson et al., 2004).

The glycemic index of a food is an indication of the length of time it takes for the food to cause a rise in blood sugar; the higher the glycemic index, the faster the rise in blood sugar. Consumption of high carbohydrate foods in combination with protein, fat or fibre has been shown to result in a slower and smaller rise in blood glucose compared with carbohydrate consumption alone (MacDonald et al., 2009). Others have studied the association between high-carbohydrate and low-carbohydrate diets with blood glucose levels and have

obtained contradictory results (Pascale et al., 1995; Gannon et al., 1998; Garg et al., 1994; Wolever et al., 2008).

However, analyzing the association between A_{1c} and combinations of foods is complex and is beyond the scope of this study. It is possible to determine factors associated with dietary adherence by analysis of individual foods. In this study, grocery store receipts were used to approximate categories of foods consumed and a three-day food record was used to approximate regular eating habits. Combinations of foods, the effects of alcohol and caffeine on blood glucose and A_{1c} or the effect of dietary fibre on A_{1c} was not considered.

The data for *mealprep* was gathered from a 15-minute telephone interview with the participant. To reduce bias, the participant did not know when the interviewer would call to ask about activities from the previous day. However, the activities of one day may not have always been typical, and since this study was conducted over the summer, less time may have been spent on meal preparation on warmer days.

Other biases possibly present in this study are:

- Since we recruited participants by informing them by newspaper, TV and poster, we had selected for people who had read the article, visited the establishment where the poster was displayed or were watching the TV when the information was aired.
- The average household income for Edmonton in 2009 was nearly $70,000 (Government of Alberta, 2010), close to the median income for respondents of approximately $70,000. Since prevalence of T2D has been associated with low socio-economic status in Canada (Ross et al., 2010), it could be assumed that participants would have a median income significantly lower than average. Perhaps due to recruitment methods (newspaper and news story on TV), we had selected for those with a higher income, or those with higher incomes may have been more interested in being part of the study.
- As this was voluntary, further selection bias was possible, as potential participants would have had to be interested in the program and be willing to

give their time for the study. It is likely that those choosing to participate had a greater interest in improving or maintaining their health and managing their diabetes than the general diabetic population in Edmonton.

- Many participants (nearly 40%) dropped out of the study. This could have caused selection bias as these people could have had time constraints or other issues that may have revealed different results than those who completed the study. Similarly, a few participants did not submit appropriate data, either through confusion or lack of time. We could not use the data from these individuals.
- Data were collected during the summer and early fall. Food consumption patterns during this time were probably much different for many participants than in other seasons. For example, some participants were consuming produce from the garden. This may have affected food choices of the participant as well as food costs, compared to winter. Also, barbecues were common among participants and would not have been in other seasons. Very warm days probably encouraged participants to purchase and consume convenience foods that required little or no cooking.
- Festivals, parties, and activities with children may have been more common for these people during the summer compared to other seasons, possibly influencing food choices and food costs.
- There were several participants who were traveling during the data collection period, possibly leading to bias in food choices and/or food costs.
- Food purchase receipts were collected for a consecutive 28 days from each participant. As two of our participants informed us, this may not have been a long enough period of time. Some grocery shoppers buy the bulk of their groceries once per month, either at the beginning or the end of the month. It would have been possible to miss the largest order of groceries for some participants, resulting in a lower estimated food cost than the actual.

6.6 Future research and policy implications

As mentioned in the introduction, we live in a fast-paced world. Time is an important factor in food choice. Fast foods and convenience foods were developed to fulfill the need to reduce the time for meal preparation and associated tasks. Many people will choose saving time over eating healthily if given a choice. This reality is not likely to change.

Unfortunately, foods that save us time are high in fat, salt and refined carbohydrates, which can contribute to ill health for people with diabetes. As well, these foods are also widely available and easily accessible to the majority of Canadians. Regular consumption of these highly processed convenience foods may contribute to undesirable health outcomes for people with diabetes.

The analysis presented in this thesis is part of a pilot study. A positive association between health outcomes and diet quality among diabetes patients was concluded in this study. The results of this study and others developed from it may be used for the development of an intervention plan for T2D patients. Policies aimed at increasing availability and accessibility of diabetes appropriate foods and perhaps decreasing availability and accessibility of energy-dense, nutrient-poor convenience and fast foods may be developed.

The results of this study suggest that cost may be a barrier to dietary adherence for T2D patients at the low-income level. Policies aimed at educating low-income diabetes patients in purchasing and preparing low-cost nutritious foods may help to improve or maintain health status of these people. These results also suggest that time may be a barrier to dietary adherence among high-income patients. Policies aimed at educating busier, high-income patients in where and how to purchase, as well as how to prepare, time-saving diabetes-appropriate foods may help improve dietary adherence and health outcomes of higher income patients.

REFERENCES

Alberta Employment and Immigration. 2007. Family Support. Health Benefits. Available at: http://employment.alberta.ca/cps/rde/xchg/hre/hs.xsl/2073.html (accessed February 12, 2010)

American Diabetes Association. 2009. Direct and Indirect Costs of Diabetes in the United States. Available at: http://www.diabetes.org/diabetes-statistics/cost-of-diabetes-in-us.jsp (accessed February 12, 2010)

Andersen, RM., Davidson, PL. 1997. Ethnicity, aging and oral health outcomes. A conceptual framework. *Advances in Dental Research* 11(2):203-209.

Anderson, AS., Dewar, J., Marshall, D., Cummins, S., Taylor, M., Dawson, J., Sparks, L. 2006. The development of a healthy eating indicator shopping basket tool (HEISB) for use in food access studies – identification of key food items. *Public Health Nutrition* 10(12):1440-1447.

Anderson, JW., Hamilton, CC., Horn, JL., Spencer, DB., Dillon, DW. and JA. Zeigler. 1991. Metabolic effects of insoluble oat fibre on lean men with type 2 diabetes. *Cereal Chemistry* 63(3):291-294.

Arimond, M. and Ruel, MT. 2004. Dietary diversity is associated with child nutritional status: Evidence from 11 demographic and health surveys. *Journal of Nutrition* 134(10):2579-2585.

Asfaw, A. 2008. Does supermarket purchase affect dietary practices of households? Some empirical evidence from Guatemala. *Development Policy Review* 26 (2): 227-243

Bachmann, M.O.; J. Eachus; C.D. Hopper; G.D. Smith; C. Propper; N.J. Pearson; S. Williams; D. Tallon and S. Frankel. 2003. Socio-economic inequalities in diabetes complications, control, attitudes and health service use: a cross-sectional study. *Diabetic Medicine* 20(11): 921-929.

Beatty, T. 2008. Expenditure dispersion and dietary quality: Evidence from Canada. *Health Econ*omics 17: 1001–1014 (2008).

Becker, GS. 1965. A theory of the allocation of time. *The Economic Journal* 75(299):493-517.

Becker, GS. 1976. The Economic Approach to Human Behavior. The University of Chicago Press, Chicago.

Becker, W. 2001. Comparability of household and individual food consumption data – evidence from Sweden. *Public Health Nutrition*: 4(5B), 1177-1182

Bernstein, AM., Bloom, DE., Rosner, BA., Franz, M. and WC. Willett. 2010. Relation of food cost to healthfulness of diet among US women. *American Journal of Clinical Nutrition* 92(5):1197-1203.

Beydoun, MA., Powell, LM. and Y. Wang. Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. *Public Health Nutrition:* 12(3):369–381

Beydoun, MA. and Y. Wang. 2008. How do socio-economic status, perceived economic barriers and nutritional benefits affect quality of dietary intake among US adults? *European Journal of Clinical Nutrition* 62:303–313

Biddle, JE. and DS Hamermesh. 1990. Sleep and the allocation of time. *The Journal of Political Economy* 98 (5): 922-943.

Birch, LL. 1998. Development of food acceptance patterns in the first years of life. *Proceedings of the Nutrition Society* (1998), 57,617-624

Blaylock, J., Smallwood, D., Kassel, K., Variyam, J and L. Aldrich. 1999. Economics, food choices, and nutrition. *Food Policy* 24(2-3): 269-286.

Birmingham, CL., Muller, JL., Palepu, A., Spinelli, JJ. and AH. Anis. 1999. The cost of obesity in Canada. *Canadian Medical Association Journal* 160(4):160:483-488

Bowman, SA., Gortmaker, SL., Ebbeling, CB., Pereira, MA and Ludwig, DS. 2004. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* 113(1):112-118

Bradford, WB. 2010. The association between individual time preferences and health maintenance habits. *Journal of Behavioral Decision Making* 30(1): 99-112.

Brastad,WA. and NJ Beall,. 1980. Method and material for prepackaging food to achieve microwave browning. Patent number: 4230924

Burney, J. and B. Haughton. 2002. EFNEP: A nutrition education program that demonstrates cost-benefit. (Research).(Expanded Food and Nutrition Education Program)(Statistical Data Included). *Journal of the American Dietetic Association* 102(1):39-45.

Cade, J., Upmeier, H., Calvert, C. and D. Greenwood. 1999. Costs of a healthy diet: analysis from the UK Women's Cohort Study. *Public Health Nutrition* 2(4):505-512.

Canadian Diabetes Association. 2010. The prevalence and Costs of Diabetes. Canadian Diabetes Association. Available at: http://www.diabetes.ca/diabetes-and-you/what/prevalence/

Capps, O. Jr., Tedford, JR. and J. Havlicek, JR. 1985.Household demand for convenience and nonconvenience foods. *American Journal of Agricultural Economics* 67(4):862-869.

Chandalia, M., Garg, A., Lutjohann, D., von Bergmann. K., Grundy, SM. and SJ Brinkley. 2000. Beneficial effects of high dietary fibre intake in patients with type 2 diabetes mellitus. *New England Journal of Medicine* 342(19):1392-1398.

Chou, S-Y., Grossman, M., Saffer, H. 2004. An economic analysis of adult obesity: results from the Behavioural Risk Factor Surveillance System. *Journal of Health Economics* 23(3):565-587.

Cobb, SL., Brown, DJ., and LL. Davis. 2006. Effective interventions for lifestyle change after myocardial infarction or coronary artery revascularization. *Journal of the American Academy of Nurse Practitioners* 18(1):31-39.

Cohen, B., Andrews, M. and SL. Kantor. 2002. Community Food Security Assessment Toolkit. USDA Economic Research Service. Ref Type: Electronic Citation.

Coffey, JT., Brandle, MB., Zhou, H., Marriot, D., Burke, R., Tabaei, BP., Engelgau, MM., Kaplan, RM., Herman, WH. 2002. Valuing health-related quality of life in diabetes. *Diabetes Care* 25(12): 2238-2243

Davis, B. and V. Tarasuk. 1994. Hunger in Canada. Agriculture and Human Values 11(4):50-57.

Dawson, KG., Gomes, D., Blanchard, JF. and KH. Kahler. 2000. The economic cost of diabetes in Canada 1998. *Diabetes Research and Clinical Practice* 50 (supp1ement): 7.

de Boer, M., McCarthy, M., Cowan, C. and I. Ryan. 2004.The influence of lifestyle characteristics and beliefs about convenience food on the demand for convenience foods in the Irish market. *Food Quality and Preference* 15 (2):155-165.

Drescher, LS. 2007. Healthy Food Diversity as a Concept of Dietary Quality: Measurement, Determinants of Consumer Demand, and Willingness to Pay. Cuvillier Verlag, Gottingen.

Drewnowski, A. 2004. Obesity and the food environment: Dietary energy density and diet costs. American Journal of Preventative Medicine 27(3S1):154-162

Drewnowski, A. and N. Darmon. 2005. The economics of obesity: dietary energy density and energy cost. *The American Journal of Clinical Nutrition* 82(1):265S-273S.

Drewnowski, A., Fiddler, EC., Dauchet, L., Galan, P. and S. Hercherg. 2009. Diet Quality Measures and Cardiovascular Risk Factors in France: Applying the Healthy Eating Index to the SU.VI.MAX Study. *Journal of the American College of Nutrition* 28(1):22–29.

Drummond, MF; Sculpher, MJ; Torrance, GW; O'Brien, BJ and GL Stoddart. 2005. Methods for the Economic Evaluation of Health Care Programs (third edition). Oxford University Press, Oxfors, New York.

Eastman, RC., Javitt, JC., Herman, WH., Dasbach, EJ., Copley-Merriman, C., Maier, W., Dong, F., Manninen, D., Zbrozek, AS., Kotsanos, J., Garfield, SA. and M. Harris. 1997. Model of complications of NIDDM. II. Analysis of the health benefits and cost-effectiveness of treating NIDDM with the goal of normoglycemia. *Diabetes Care* 20(5): 735-744.

Edmonton Economic Development Corporation. 2010. Monthly Key Economic Indicators. Edmonton Economic Development Corp. Available at: http://www.edmonton.com/for-business/edmonton_economic_statistics.aspx (accessed November 2, 2010)

Estruch, R., Martinez-Gonzalez, MA., Corella, D., Salas-Salvado, J., Ruiz-Gutierrez, V., Covas, MI., Fiol, M., Gomez-Gracia, E., Lopez-Sabater, MC., Vinyoles, E., Aros, F., Conde, M., Lahoz, C., Lapetra, J., Saez, G., and E. Ros. 2006. Effects of a Mediterranean-style idet on cardiovascular risk factors. A randomized trial. *Annals of Internal Medicine* 145(1):1-11.

Ettner, SL., Cadwell, BL., Russell, LB., Brown, A., Karter, AJ., Safford, M., Mangione, C., Beckles, G. and WH. Herman. 2009. Investing time in health: do socioeconomically disadvantaged patients spend more or less extra time on diabetes self-care? *Health Economics* 18(6):645-663.

esha Research. 2006. The Food Processor. Available at: http://www.esha.com/foodprosql (accessed December 31, 2010)

Evans, JMM., Newton, RW., Rutas, DA., MacDonald, TM. and AD. Morris. 2000. Socio-economic status, obesity and prevalence of Type 1 and Type 2 diabetes mellitus. *Diabetic Medicine* 17(6):478-480.

Fernandez, E., Negri, E., La Vecchia, C. and S. Franceschi. 2000. Diet diversity and colorectal cancer *Preventive Medicine* 31(1):11–14

Flight, I., Leppard, P. and DN. Cox. 2003. Food neophobia and associations with cultural diversity and socio-economic status amongst rural and urban Australian adolescents. *Appetite* 41(1):51-59.

Florence, MD., Asbridge, M., and PJ. Veugelers. 2008. Diet quality and academic performance. *Journal of School Health* 78(4):209-215.

Florkowski, WJ., Moona, W., Resurreccionb, AVA., Jordanovc, J., Paraskova, P., Beuchatb, LR., Murgovd, K. and MS Chinnanb. 2000. Allocation of time for meal preparation in a transition economy. *Agricultural Economics* 22 (2):173-183.

Franceschi, S., Favero, A., La Vecchia, C., Negri, E., Dal Maso, L., Salvini, S., Decarli, A., Giacose, A. 1995. Influence of food groups and food diversity on breast cancer risk in Italy. *International Journal of Cancer* 63(6):785-789.

Franco, M., Diez-Roux, AV., Nettleton, JA., Lazo, M., Brancati, F., Cabellero, B., Glass, T. and LV. Moore. 2009. Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. *American Journal of Clinical Nutrition* 89(3):897-904.

Franz, MJ., Bantle, JP., Beebe, CA., Brunzell, JD., Chiasson, JL., Garg, A., Holzmeister, LA., Hoogwerf, B., Mayer-Davis, E., Mooradian, AD., Purnell, JQ. and M. Wheeler. 2002. Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care* 25(1):149-198.

Gannon, MC., Nuttall, FQ., Westphal, SA., Fang, S. and Ecran-Fang, N. 1998. Acute metabolic response to high-carbohydrate, high-starch meals compared with moderate-carbohydrate, low-starch meals in subjects with type 2 diabetes. *Diabetes Care* 21(10):1619-1626

Garg, A., Bantle, JP., Henry, RR., Coulston, AM., Griver, KA., Raatz, SK., Brinkley, L., Chen, Y-DA., Grundy, SM., Huet, BA. and GM Reaven. 1994. Effects of varying carbohydrate content of diets in patients with non *insulin*-dependent diabetes mellitus. *Journal of the American Medical Association* 271(18):1421-1428.

Garvello, W., Giordano, L., Bosetti, C., Talamini, R., Negri, E., Tavini, A., Maisoneuve, P., Franceschi, S., La Vecchia, C. 2008. Diet diversity and the risk of oral and pharyngeal cancer. *European Journal of Nutrition* 47(5):280–284

Giacco, R., Parillo, M., Rivellese, AA., Lasorella, GL., Giacco, A., D'Episcopo, L., Riccardi, G. 2000. Long-term dietary treatment with increased amounts of fiber-rich low–glycemic index natural foods improves blood glucose control and reduces the number of hypoglycemic events in type 1 diabetic patients. *Diabetes Care* 23(10): 1461-1466.

Gilmer, TP., O'Connor, PJ., Manning, WG. and WA. Rush. 1997. The cost to health plans of poor glycemic control. *Diabetes Care* 20(12): 847-1853.

Gilmer, TP., O'Connor, PJ., Rush, WA., Crain, AL., Whitebird, RR., Hanson, AM. and LI Solberg. 2005. Predictors of health care costs in adults with diabetes. *Diabetes Care* 28(1):59-64.

Glanz, KG., Basil, M., Maibach, E., Goldberg, J. and D. Snyder. Why Americans eat what they do: Taste, nutrition, cost, convenience, and weight control concerns as influences of food consumption. *Journal of the American Dietetic Association* (1998) 98(10):1118-1126.

Gougeon, R., Aylward, N., Nichol, H., Quinn, K. and D. Whitham. 2008. Nutrition Therapy. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. *In* Canadian Diabetes Association. Canadian Journal of Diabetes. Canadian Diabetes Association 2008 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada.

Government of Alberta. 2010. 2009 Alberta Wage and Salary Information. *Employ*ment and Immigration, Government of Alberta. Available at: http://employment.alberta.ca/BI/2653.html (accessed December 5, 210)

Government of Alberta. 2010. Canadian Consumer Trends in Obesity and Food Consumption. Agriculture and Rural Development.

Government of Alberta. 2010. Seniors and Community Supports. Household Income. Available at: http://www.seniors.alberta.ca/policy_planning/factsheet_seniors/income/household/ (accessed November 1, 2010)

Gray, A., Raikou, M., McGuire, A., Fenn, P., Stevens, R., Cull, C., Stratton, I., Adler, A., Holman, R. and R. Turner. 2000. Cost effectiveness of an intensive blood glucose control policy in patients with type 2 diabetes: economic analysis alongside randomized controlled trial (UKPDS 41). *British Medical Journal* 2000 320(7246):1373-1378.

Gronau, R., 1973. The intrafamily allocation of time: the value ofthe housewives' time. *American Economic Rev*iew 63, 634-65 1.

Grossman, M. 1972. On the concept of health capital and the demand for health. *Journal of Political Economy* 80(2):223-255.

Guenther, PM., Krebs-Smith, SM., Reedy, J., Britten, P., Juan, WY, Lino, M., Carlson, A., Hiza, HA. and PP. Basiotis. 2007. Healthy Eating Index 2005. Center for Nutrition Policy and Promotion, USDA.

Haines, PS., Seiga-Riz, AM. and BM. Popkin. 1999. The Diet Quality Index revised: A measurement instrument for populations. *Journal of the American Dietetic Association* 99(6):697-704.

Halpern, D. 2005. How time - flexible work policies can reduce stress, improve health, and save money. *Stress and Health* 21(3):157-168.

Hann, CS., Rock, CL., King, I. and A. Drewnowski. 2001 Validation of the Healthy Eating Index with use of plasma biomarkers in a clinical sample of women. *American Journal of Clinical Nutrition* 74(4):479–86.

Hardin, G. 1957. Biology: Its Human Implications. W. H. Freeman and Company, San Francisco.

Health Canada, 2005a. Dietary Reference Intakes. Reference Values for the Elements. Available at: http://www.hc-sc.gc.ca/fn-an/nutrition/reference/table/ref_elements_tbl-eng.php (accessed November 15, 2010)

Health Canada, 2005b. Dietary Reference Intakes. Reference Values for Vitamins. Available at: http://www.hc-sc.gc.ca/fn-an/nutrition/reference/table/ref_vitam_tbl-eng.php (accessed November 15, 2010)

Health Canada. 2006. It's Your Health – Type 2 Diabetes. Available at: http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/diseases-maladies/diabete-eng.php (accessed September 14, 2010)

Health Canada. 2007. Eating Well With Canada's Food Guide. A Resource for Educators and Communicators. Health Canada, Ottawa,

Health Canada. 2007. My Food Guide Serving Tracker. Available at: http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/table_female-femme_age51plus-eng.pdf (accessed October 28, 2010)

Health Canada. 2011. Food and Nutrition. Household Food Insecurity in Canada in 2007-2008; Key Statistics and Graphics. Available at: http://www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/insecurit/key-stats-cles-2007-2008-eng.php#a. (accessed January 26, 2011)

Hemphill, E., Raine, K., Spence, JC. and KE. Smoyer-Tomic. 2008. Exploring obesogenic food environments in Edmonton, Canada: The association between socioeconomic factors and fast-food outlet access. *American Journal of Health Promotion* 22(6):426-432.

Horowitz, CR., Colson, KA., Hebert, PL., Lancaster, K. 2004. Barriers to buying healthy foods for people with diabetes: Evidence of environmental disparities. *American Journal of Public Health* 94(9):1549-1554.

Human Resources and Skills Development Canada, 2006. Indicators of well-being in Canada. Leisure. Government of Canada. Available at: http://www4.hrsdc.gc.ca/d.4m.1.3n@-eng.jsp?did=10 (accessed November 10, 2010)

Human Resources and Skills Development Canada, 2009. Indicators of well-being in Canada. Work. Government of Canada. Available at: http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=19#M_1 (accessed November 12, 2010)

Huston, SJ. and MS. Finke, MS. 2003. Diet Choice and the Role of Time Preference. *Journal of Consumer Affairs* 37(1):143-160.

Inagami, S., Cohen, DA., Finch, BK., Asch, SM. 2006. You are where you shop: Grocery store locations, weight, and neighborhoods. *American Journal of Preventative Medicine* 31(1):10-17.

Jeffrey, RW., Baxter, J., McGuire, M. and J. Linde. Are fast food restaurants an environmental risk factor for obesity? 2006. *The International Journal of* Behaviour*al Nutrition and Physical Activity* 3(1):35-40.

Jekanowski, MD. 1999. Causes and consequences of fast food sales growth – statistical data included. Food Industry. Bnet.

Jetter, K.M. and D.L. Cassady.2008. The availability and cost of healthier food alternatives. *American Journal of Preventative Medicine* 30(1):38-44.

Johnson, JA., Polar, SL. and SR. Majumdar. 2006. Health care use and costs in the decadeafter identification of Type 1 and Type 2 diabetes: A population-based study. *Diabetes Care* 29(11):2403-2408

Johnston, KL., Clifford, MN. And LM. Morgan. 2003. Coffee acutely modifies gastrointestinal hormone secretion and glucose tolerance in humans: glycemic effects of chlorogenic acid and caffeine. *American Journal of Clinical Nutrition* 2003;78:728–33.

Kant, AK. 1996. Indices of overall diet quality: a review. *Journal of the American Dietetic Association* 96(8):785-791.

Kant, AK., Graubard, BI., Schatzkin, A. 2004. Dietary patterns predict mortality in a national cohort: The National Health Interview survey, 1987 and 1992. *Journal of Nutrition* 134(7): 1793–1799

Kant, AK., Schatzkin, A., Harris, TB., Ziegler, RG., Block, G. 1993. Dietary diversity and subsequent mortality in the First Nation Health and Nutrition Examination Survey Epidemiological Follow-up Study. *American Journal of Clinical Nutrition* 57(3):434-440

Katzmarzyk, PT. and C. Mason. 2006. Prevalence of class I, II and III obesity in Canada. *Canadian Medical Association Journal* 174(2):156-157.

Kennedy, E. 2004. Dietary diversity, diet quality, and body weight regulation. *Nutrition Reviews* 62(7):S78-S81

Kennedy, GL., Pedro, MR., Seghieri, C., Nantel, G. and I. Brower. 2007. Dietary diversity scire is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. *Journal of Nutrition* 137(2):472-477.

Kennedy, PW. 2010. Economic incentives for a healthy diet: a comparison of policies in a Canadian context. *The Berkeley Electronic Journal of Economic Analysis & Policy* 10(1):1935-1682.

Khaw, KT., Wareham, N., Bingham, S., Luben, R., Welch, A. and N. Day. 2004. Association of hemoglobin A_{1c} with cardiovascular disease and mortality in adults: The European Prospective Investigation into Cancer in Norfolk. *Annals of Internal Medicine* 141(6):413-420.

Kirkpatrick, S. and V. Tarasuk. 2003. The relationship between low income and household foodexpenditure patterns in Canada. *Public Health Nutrition*: 6(6):589–597

Kitagawa T, M. Owada, T. Urakami and M. Tajima.1994. Epidemiology of Type I (*insulin*-dependent) and Type II (non-*insulin*-dependent) diabetes mellitus in Japanese children. *Diabetes Research and Clinical Practice* 24 [Supplement]:7±13.

Kim, S., Haines, PS., Seiga-Riz, AM. and Popkin, BM. 2003. The Diet Quality Index-International (DQI-I) provides an effective tool for cross-national comparison of diet quality as illustrated by China and the United States. *Journal of Nutrition* 133(11):3476-3484.

Lakdawalla, D. and T. Philipson. 2009. The growth of obesity and technological change. *Economics and Human Biology* 7(3):283-293.

Lambe, J., Kearney, J, Becker, W., Hulshof, K., Dunne, A. and MJ. Gibney. 1998. Predicting percentage of individuals consuming foods from percentage of households purchasing foods to improve the use of household budget surveys in estimating food chemical intakes. *Public Health Nutrition*: 1(4):23+24 7 239.

Lancaster, K. 1966. A New Approach to Consumer Theory. *Journal of Political Economy* 74(2):132-157.

Landon, S., McMillan, ML., Muralidharan, V. and M. Parsons. 2006. Does health-care spending crowd out other provincial government expenditures? *Canadian Public Policy* 32(2):121-141.

LaPorte, R. E., Kuller, LH., Kupfer, DJ., McPortland, RJ., Matthews, G. and Caspersen, C. 1979. An objective measure of physicalactivity for epidemiologic research. *American Journal of Epidemiology* 109:158-168.

Laraia, BA., Seigi-Riz, AM., Kaufman. JS., Jones, SJ. 2004. Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventative Medicine* 39(5): 869-875.

Laroche, HH., Davis, MM., Forman, J., Palmisano, G. and M. Heisler. 2007. What about the children? The experience of families involved in an adult-focused diabetes intervention. *Public Health Nutrition* 11(4):427-436.

Larson, NI., Perry, CL., Story, M. and D. Neumark-Sztainer. 2006. Food preparation by young adults is associated with better diet quality. *Journal of the American Dietetic Association* 106(12):2001-2007.

Lewit, EM., Hyland, A., Kerrebrock, K. and KM. Cummings. 1997. Price, public policy and smoking in young people. *Tobacco Control* 6(supplement 2):S17-S24.

Lucenteforte, E., Garavello, W., Bosetti, C., Talamini, R., Zambon, P., Franceschi, S., Negri, E. and C. La Vecchia. 2008. Diet diversity and the risk of squamous cell esophageal cancer. *International Journal of Cancer* 123(10):2397–2400.

MacDonald, K., Lowe, JM., Barker, D., Mensch, M. and J. Attia. 2009. Effect of popular takeaway foods on blood glucose levels in type 1 diabetes mellitus patients on intensive *insulin* therapy. *International Journal of Clinical Practice* 63(2):189–194.

Maillot, M., Darmon, N., Darmon, M., Lafay, L., Drewnowski, A. 2007. Nutrient-dense food groups have high energy costs: An econometric approach to nutrient profiling J*ournal of Nutrition* 137(7):1815-1820.

Maillot, M., Ferguson, EL., Drewnowski, A., Darmon, N. 2008. Nutrient profiling can help identify foods of good nutritional quality for their price: a validation study with linear programming J*ournal of Nutrition* 138(6):1107-1113

Manuel, DG and SE. Schultz. 2004. Health-Related Quality of Life and Health-Adjusted Life Expectancy of People with Diabetes in Ontario, Canada, 1996–1997 *Diabetes Care* 27(2):407-414.

Martin, SL., Howell, T., Duan, Y. and M. Walters. 2006. The feasibility and utility of grocery receipt analyses for dietary assessment. *Nutrition Journal* 5(1):10-16.

McCabe-Sellers, BJ., Bowman, S., Stuff, JE., Champagne, CM., Simpson, PM. and ML. Bogle. 2007. Assessment of the diet quality of US adults in the Lower Mississippi Delta. *The American Journal of Clinical Nutrition* 86(3):697-706.

Mela, D. 2009. Symposium on 'Functionality of nutrients and behaviour' Food choice and intake: the human factor. The 3rd French–British Meeting on Nutrition, a joint meeting of the Nutrition Society, Association Française de Nutrition and Société de Nutrition et de Diététique de Langue Française was held at Nancy, France on 30 September–2 October 1998. *Proceedings of the Nutrition Society* 58, 513–521 513.

Meyerhoefer, CD. and ES. Leibtag. 2010. A spoonful of sugar helps the medicine go down: the relationship between food prices and medical expenditures on diabetes. *American Journal of Agricultural Economics* 92(5):1271-1282.

Mitchell, RP. 1980. Automatically ventable sealed food package for use in microwave ovens. Patent number: 4210674.

Monsivais, P., Drewnowski, A. 2009. Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher economic status. *Journal of the American Dietetic Association* 105(5):814-822.

Moore, LV. and Diez Roux, AV. Associations of neighbourhood characteristics with the location and type of food stores. *American Journal of Public Health* 96(2): 325-331.

Morland, K., Diez Roux, AV., Wing, S. 2006. Supermarkets, other food stores and obesity: The atherosclerosis risk in communities study. *American Journal of Preventative Medicine* 30(4):333–339

Mulder, M., Ranchor, AV., Sanderman, R., Bouma, J. and WJ. Van den Heuvel. 1998. The stability of lifestyle behaviour. *Internal Journal of Epidemiology* 27(2):199-207

Murray, RP., Connett, JE., Rand, CS., Pan, W. and NR. Anthonisen. 2002. Persistence of the effect of the Lung Health Study (LHS) intervention over eleven years. *Preventive Medicine* 35 (4):314–319.

Nakajima, H., Kaneita, Y., Yokoyama, E., Harano, S., Tamaki, T., Ibuka, E., Kaneko, A., Takahashi, I., Umeda, T., Nakaji, S. and T. Ohida. Association between sleep duration and hemoglobin A_{1c} level. *Sleep Medicine* 9(7):745-752.

National Diabetes Information Clearinghouse (NDIC). 2007. National Diabetes Statistics, 2007. Available at: http://diabetes.niddk.nih.gov/dm/pubs/statistics/#what (accessed August 10, 2010)

Nelson, K.; W. Cunningham; R. Andersen; G. Harrison and L. Gelberg (2001). Is Food Insufficiency Associated with Health Status and Health Care Utilization Among Adults with Diabetes? *Journal of General Internal Medicine* 16(6):404-411.

Nestle, M. 2002. Food politics. How the Food Industry Influences Nutrition and Health. University of California Press, Berkeley, California.

Neumark-Sztainer, D., Story, M., Perry, C. and MA Casey. 1999. Factors influencing food choices in adolescents: Findings from the focus-group discussions with adolescents. *Journal of the American Dietetic Association* 99(8):929-937.

Newby, PK., Hu, F., Rimm, EB., Smith-Warner, SA., Feskanich, D., Sampson, L. and WC. Willett. 2003. Reproducibility and validity of the Diet Quality Index Revised as assessed by use of a food-frequency questionnaire. *American Journal of Clinical Nutrition* 78(5):941–949.

O'Donoghue T, Rabin M. The economics of immediate gratification. *Journal of Behavioural Decision Making* 2000;13:233–50.

Ogden, J. 2010. The Psychology of Eating: From Healthy to Disordered Behaviour. 2nd ed., Wiley-Blackwell, West Sussex.

Ohinmaa, A., Jacobs, P., Simpson, S. and JA. Johnson. The Projection of Prevalence and Costof Diabetes in Canada: 2000 to 2016. *Canadian Journal of Diabetes*. 28(2):1-8.

Orchard, TJ., Temprosa, M., Golding, R., Haffner, S., Ratner, R., Marcovina, S. and S. Fowler. 2005. The effect of metformin and intensive lifestyle intervention on the metabolic syndrome: The diabetes prevention randomized trial. *Annals of Internal Medicine* 142(8):611-619.

Owen, RW., Giacosa, A., Hull ,WE., Haubner, R., Wurtele ,G., Spiegelhalder, B. and H. Bartsch. 2000. Olive-oil consumption and health: the possible role of antioxidants. *The Lancet Oncology* 1(1):107–112.

Palmer, AJ., Sendi, PP and GA Spinas. 2000. Applying some UK prospective diabetes study results to Switzerland: the cost-effectiveness of intensive glycaemic control with metformin versus conventional control in overweight patients with type 2 diabetes. *Schweiz Med Wochenschr* 130(27):1034-1040.

Pascale RW, Wing RR, Butler BA, Mullen M, Bononi P. 1995. Effects of a behavioural weight loss program stressing calorie restriction versus calorie plus fat restriction in obese individuals with NIDDM or a family history of diabetes. *Diabetes Care* 18(9):1241– 8.

Patil, GP. and Taillie, C. 1982. Diversity as a concept and its measurement. *Journal of the American Statistical Association* 77(1):548-561.

Patterson, RE., Haines, PS. And BM. Popkin. 1994. Diet Quality Index: Capturing a multidimensional behaviour. *Journal of the American Dietetic Association* 94(1):57-64.

Pereira, MA., Kartashov, AI., Ebbeling, CB., Van Horn, L., Slattery, ML., Jacobs, DR. Jr. and Ludwig, DS. 2005. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *The Lancet* 365(9453):36-42.

Popkin, BM., Seiga-Riz, AM. and PS. Haines. 1996. A comparison of dietary trends among racial and socioeconomic groups in the United States. *The New England Journal of Medicine* (Special Article):716-720.

Powers, M. 2003. American Dietetic Association Guide to Eating Right When You Have Diabetes. John Wiley & Sons, Hoboken, New Jersey.

Public Health Agency of Canada. 2003. Diabetes. Public Health Agency of Canada. Government of Canada. Available at: http://www.phac-aspc.gc.ca/publicat/dic-dac2/english/1_{1c}hap1-eng.php (accessed September 20, 2010)

Public Health Agency of Canada. 2008. The Face of Diabetes in Canada. Available at: http://www.phac-aspc.gc.ca/cd-mc/diabetes-diabete/face-eng.php (accessed September 20, 2010)

Qaseem, A., Vijan, S., Snow, V., Cross, JT., Weiss, KB. and DK. Owens. 2007. Glycemic control and type 2 *diabetes mellitus.* The optimal hemoglobin A_{1c} targets. A guidance statement from the American College of Physicians. *Annals of Internal Medicine*147(6):417-422.

Raynor, HA., Kilanowski, CK., Esterlis, I., Epstein, LH. 2002. A cost-analysis of adopting a healthful diet in a family-based obesity treatment program. *Journal of the American Dietetic Association* 102(5):645-56.

Reilly, M. Working wives and convenience consumption. 1982. T*he Journal of Consumer Research* 8(4):407-418.

Robinson, LE., Savani, S., Battram, DS., McLaren, DH., Sathasivam, P. and TE. Graham. Caffeine ingestion before an oral glucose tolerance test impairs blood glucose management in men with type 2 diabetes. 2004. *Journal of Nutrition* 134(10): 2528–2533

Rosenbloom, AL., Joe, JR. Young, RS. and WE Winter. 1999. Emerging epidemic of type 2 diabetes in youth. *Diabetes Care* 22(2):345-354.

Ross, NA., Gilmour, H. and K. Dasgupta. 2010. 14-year diabetes incidence: The role of socio-economic status. Statistics Canada.

Ruel, MT. 2002. Is Dietary Diversity an Indicator of Food Security or Dietary Quality? A Review of Measurement Issues and Research Needs. FCND Discussion Paper No. 140. Food Consumption and Nutrition Division International Food Policy Research Institute Washington, D.C.

Sabates, R., Gould, BW. And Villarrel, HJ. 2001. Household composition and food expenditures:a cross-country comparison. *Food Policy* 26(6): 571–586

Savy, M., Martin-Previl, Y., Sawadogo, P., Kameli, Y. and F. Delpeuch. 2005. Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *European Journal of Clinical Nutrition* 59(1): 703–716

Schlundt, D G; Rea, M R; Kline, S S; and J W Pichert. 1994. Situational obstacles to dietary adherence for adults with diabetes. *Journal of the American Dietetic Association* 94(8): 874-6.

Selvin E, Marinopoulos S, Berkenblit G, Rami, T., Brancati, FL., Powe, NR. and SH Golden. 2004. Meta-analysis: glycosylated hemoglobin and cardiovascular disease in diabetes mellitus. *Annals of Internal Medicine* 141(6):421–431.

Shai, I., Wainstein, J., Harman-Boehm, I., Raz, I., Fraser, D., Rudrich, A. and MJ. Stampfer. 2007. Glycemic effects of moderate alcohol intake among patients with type 2 diabetes. *Diabetes Care* 30(12):3011-3016.

Shatenstein, B., Nadon, S., Godin, C. and G. Ferland. 2005. Diet quality of Montreal-area adults needs improvement: Estimates from a self-administered food frequency questionnaire furnishing a dietary indicator score. *Journal of the American Dietetic Association* 105(8):1251-1260.

Smoyer-Tomic, KE., Spence, JC. And C. Amrhein. Food deserts in the prairies? Supermarket accessibility and neighborhood need in Edmonton, Canada. *The Professional Geographer* 58(3):307-326.

Statistics Canada. 1999. Health Reports. Catalogue no. 82-003-XIE. 11(9).

Stipanuk, M. 2000. Biochemical and Physiological Aspects of Human Nutrition. W.B. Saunders Company, Philadelphia.

Stratton, IM., Adler, AI., Neil, HAW., Matthews, DR., Manley, SE., Cull, CA., Hadden, D, Turner, RC. and RR. Holman. 2000. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *British Medical Journal* 321(7258):405-412.

Testa, MA., Simonson, DC. and RR. Turner. 1998. Valuing quality of life and improvements in glycemic control in people with type 2 diabetes. *Diabetes Care* (supplement 3) C44-52.

Thiele, S., Mensink, GBM. and R. Beitz. 2003. Determinants of diet quality. *Public Health Nutrition* 7(1), 29–37

Thorne-Lyman, AL., Valpiani, N., Sun, K., Semba, RD., Klotz, CL, Kraemer, K., Akhter, N., dePee, S., Moench-Pfanner, R., Sari, M. and MW. Bloem.2010. Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to financial crisis. *Journal of Nutrition* 140(1):182S-188S.

Tjepkema, M. 2004. Adult obesity in Canada: Measured height and weight. Statistics Canada.

Tremblay, A., Sevigny, J., Leblanc, C. and Bouchard, C. 1983. The reproducibility of a three-day dietary record. *Nutrition Research* 3(6):819-830.

Trichopoulou, A., Costacou, T., Bamia, C. and D. Trichopoulou. 2003. Adherence to a Mediterranean Diet and survival in a Greek population. *The New England Journal of Medicine* 348(26):2599-2608.

Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, ML., Gnardellis, C., Lagiou, P., Polychronopoulos, E., Vassilakou, T., Lipworth, L. and D. Trichopoulos. 1995. Diet and overall survival in elderly people. *British Medical Journal* 311(7018):1457-1460

Tur, JA., Romaguera, D. and A. Pons. 2005. The Diet Quality Index-International (DQI-I): is it a useful tool to evaluate the quality of the Mediterranean diet? *British Journal of Nutrition* 93(3):369–376

Turner, BC., Jenkins, E., Kerr, D., Sherwin, RS. And DA. Cavan. 2001. The effect of evening alcohol consumption on next-morning glucose control in type 1 diabetes. *Diabetes Care* 24(11):1888-1893.

Turrell, G., Blakely, T., Patterson, C., Oldenburg, B. 2004. A multilevel analysis of socioeconomic (small area) differences in household food purchasing behaviour. *Journal of Epidemiology and Community Health* 58(1):208-215.

United States Department of Agriculture. 2008. *Food Security in the United States*. Available at: http://www.ers.usda.gov/Briefing/FoodSecurity/ (accessed January 4, 2010)

United States Department of Agriculture. 1995. The Healthy Eating Index. Center for Nutrition Policy and Promotion. CNPP-1. Available at: http://www.cnpp.usda.gov/publications/hei/HEI89-90report.pdf (accessed December 4, 2010)

Veeman, T. and R. Gray. 2009. Agricultural Production and Productivity in Canada. Choices: *The Magazine of Food, Farm and Resource Issues*. Agricultural and Applied Economics Association.

Vigan, S., Stuart, ND., Fitzgerald, JT., Ronis, DL., Hayward, RA., Slater, S. and TP. Hofer. 2005. Barriers to following dietary recommendations in type 2 diabetes. *Diabetic Medicine* 22(1):32-38.

Vozoris, NT. and Tarasuk, VS. 2003. Household food insufficiency is associated with poorer health. *Journal of Nutrition* 133(1)120-126.

Wing, RR., Venditti, E., Jakicic, JM, Polley, BA. And W. Lang. 1998. Lifestyle intervention in overweight individuals with a family history of diabetes. *Diabetes Care* 21(3):350-359.

Weinstein, SJ., Vogt, TM. and SA Gerrior. 2004. Healthy eating index scores are associated with blood nutrient concentrations in the Third National Health and Nutrition Examination Survey. *Journal of the American Dietetic Association* 104(4):576-584.

Waijers, MCM., Feskens, EJM. and MC. Ocke. 2007. A critical review of predefined diet quality scores. *British Journal of Nutrition* 97(2):219–231

Wolever, TMS., Gibbs, AL., Mehling, C., Chiason, JL., Connelly, PW., Josse, RG., Leiter, LA., Maheux, P., Rabasa-Lhoret, R., Roger, NW. and EA. Ryan. 2008. The Canadian Trial of Carbohydrates in Diabetes (CCD), a 1-y controlled trial of low-glycemic-index dietary carbohydrate in type 2 diabetes: no effect on glycated hemoglobin but reduction in C-reactive protein. *The American Journal of Clinical Nutrition* 87(1):114-125.

Williamson, AR., Hunt, AE., Pope, JF. and NM. Tolman. 2000. Recommendations of dieticians for overcoming barriers to dietary adherence in individuals with diabetes. *The Diabetes Educator* 26(2):272-279.

Wolever, TM., Jenkins, DJ., Vuksan V., Jenkins, AL., Buckley, GC., Wong, GS. and RG. Josse. 1992. Beneficial effect of a low glycaemic index diet in type 2 diabetes. *Diabetic Medicine*. 1992(5):451-8.

Woodruff, SJ., Hanning, RM., Lambraki, I, Storey, KE. and L. McCargar. 2008. Healthy Eating Index-C is compromised among adolescents with body weight concerns, weight loss dieting, and meal skipping. *Body Image* 5(4):404-408.

Wooldridge, JM. 2006. Introductory Econometrics. A Modern approach. Thomson South-Western, Ohio, USA.

Wooldridge, KL., Wallston, KA., Graber, AL., Brown, AW. and P. Davidson. The relationship between health beliefs, adherence and metabolic control of diabetes. *The Diabetes Educator* 18(6): 495-500.

World Health Organization. 2003. Diet, Nutrition and the Prevention of Chronic Diseases. World Health Organization

Zick, CD., Smith, KR., Fan, JX., Brown, BB., Yamada, I., Kowaleski-Jones, L. 2009. Running to the Store? The relationship between neighborhood environments and the risk of obesity. *Social Science and Medicine* 69(10): 1493-1500.

Zimmet, P., Albert, KGMM. and J. Shaw. 2001. Global and societal implications of the diabetes epidemic. *Nature* (414):782-787.

APPENDICES

APPENDIX A: Measurement protocol

Height and weight

The device used for measurements was a wall mounted digital height scale, or standiometer, which was available for use at the HNRU. Participants were measured in light clothing without shoes. Hats and hairpieces were removed. This scale must be calibrated by ensuring that the headpiece reads the same as the distance from the bottom of the standiometer to the floor (measured by staff at the HNRU) when at the lowest possible point on the scale. Press the + or – keys until it reads this.

Weight was also measured at the HNRU on a digital scale, in light clothing without shoes. No calibration was necessary, as this scale is calibrated periodically by staff at the HNRU.

Heights and weights were taken three times, and the average of the readings was recorded.

Waist and hip

Standard measuring tape was used to measure waist and hip. Proper protocol was used. Measurements were taken only after three consecutive practice measurements revealed the same result.

APPENDIX B: Recruitment of participants

Ethics approval to recruit participants for the nutrition/economics section of the PANDA study was granted June 16, 2009. On June 26, we began calling participants to schedule information sessions.

Registry

I called participants from a list of names gathered from another similar study. There were 21 possible participants on this list. Several did not fit the eligibility criteria and several were not interested or could not participate for various reasons. Over a span of 5 days, we recruited a total of 10 participants from this list.

Posters

We were told by the investigators that we should exhaust the registry list before using posters. On July 1/09, we began distributing posters around Edmonton. Posters were placed at various retail outlets during the first 2 weeks of July.
List of poster locations:

- Safeway: 109 Street; Oliver
- Champion Foods: Oliver
- Save-On Foods: downtown
- University of Alberta: Bus stop shelter; SUB (4 locations); Butterdome (5 Locations); HUB mall (3 locations)
- London Drugs: Oliver
- Grant MacEwan College: gym.
- World Health Club: downtown
- Kinsmen Sports Centre
- Safeway: Capilano; Bonny Doon; Millwoods; Westmount
- Sobeys: Millwoods
- Shoppers Drug Mart: Millwoods; Westmount

See below for poster used in recruitment

PANDA Physical Activity & Nutrition for Diabetes in Alberta

Physical Activity and Nutrition for Diabetes in Alberta (PANDA)

DO YOU HAVE

DIABETES?

Researchers at the University of Alberta are doing a study to find out about you and your diabetic diet
If you:

- ***Have type 2 diabetes***
- ***Are 18 years and above***
- ***Do not have severe digestive disorders (colitis, irritable bowel etc.)***

We invite you to participate in our study:

Study Coordinators
Denise Maxwell & Gayathiri Durairaj
Contact us at: Phone: (780)-248-1501 and leave a message
Email: pandaresearch@med.ualberta.ca

For more information http://www.ales.ualberta.ca/afns/PANDA.cfm

PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca	PANDA 780-248-1501 pandaresearch@med.ualberta.ca

Posters were unsuccessful for recruitment. Grocery stores have their poster boards almost hidden and it is generally only people looking to buy and/or sell something that even look at these things. Drug stores do not allow such posters in the main part of their stores, but are willing to put them in their staff rooms. Poster boards in fitness centres are almost hidden. Five (possibly 6) participants were recruited by poster.

Newspaper advertisements
Although unsuccessful, newspaper ads were slightly better for recruitment than posters, as well as being less time-consuming. Advertisements were run in the St. Albert Gazette during the week of July 21, Metro (Edmonton) and 24 hours (Edmonton) during the second and third week of July. An advertisement was run in the Sherwood Park News and Western Dairy Farmer (Leduc news) during the fourth week of July.

See below for newspaper advertisements used in recruitment

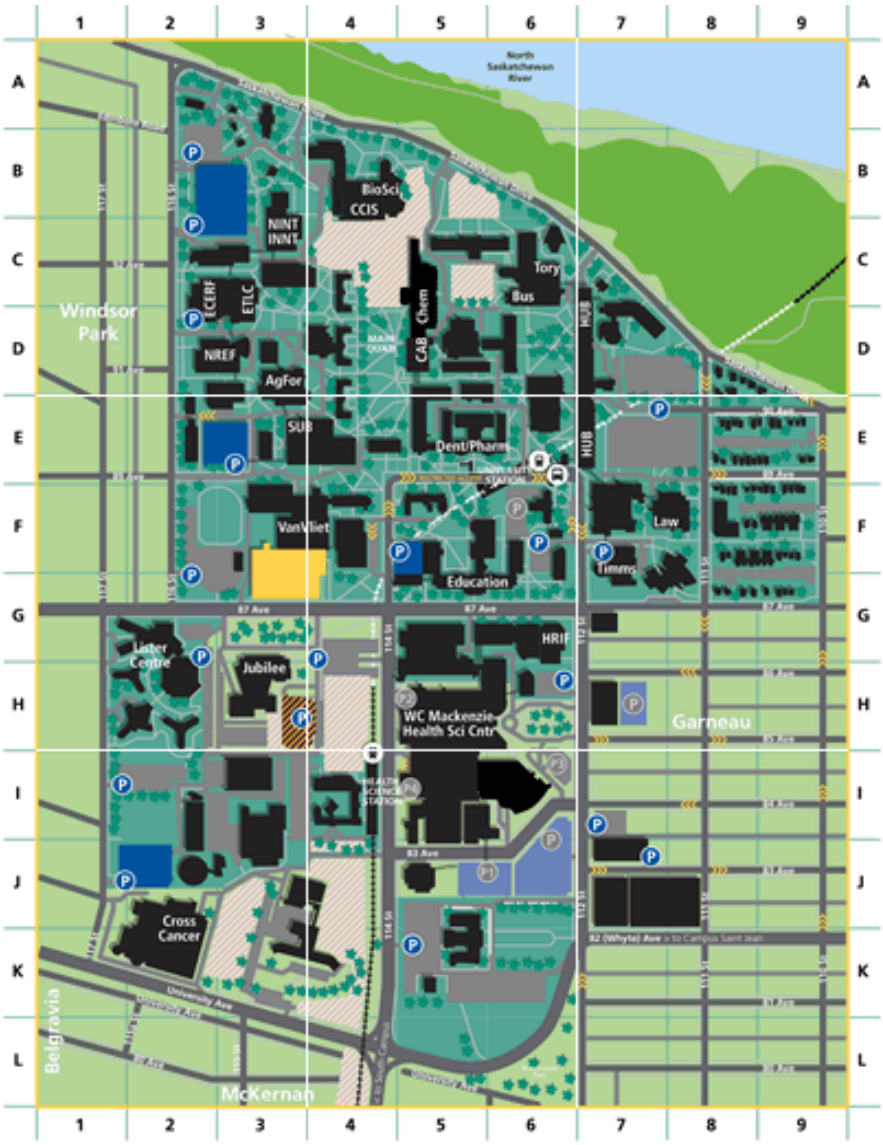
Television news story
A four-minute news story was aired on Global Edmonton News (Health Matters) at approximately 6:25PM on August 4/09. The principal investigator (Catherine Chan) told the media what the study was about, the purpose, where we were at with data collection, and what we were trying to achieve. Contact information was given. The following day, more than 20 phone messages were left and calls were still coming in. 20-30 email messages were in the *pandaresearch* mailbox.

Newspaper news stories
A short article was published in the *Edmonton Journal* (August 14) and *Sherwood Park News* (August 9).
Link to Sherwood Park News story August/09
http://www.sherwoodparknews.com/ArticleDisplay.aspx?e=1693668

Both the television and newspaper media releases were highly effective in recruiting participants. Throughout the month of August, it was difficult for 2 people to keep up with the flow of interested participants. We were also receiving calls and emails from diabetes patients from outside the Edmonton area. These people were not eligible and did not participate in the study.

Word of mouth
Many patients with diabetes know other diabetes patients. Some of the participants in this study volunteered to tell friends and family members with type 2 diabetes about this study.

APPENDIX C: Directions and map to the PANDA study information session



Parking is available at E3 (Stadium Parking Lot – near SUB and the Agriculture-Forestry Centre)

We are conducting our study at the Human Nutrition Research Unit (HNRU) in the AgFor building (3rd Floor)

AgFor (Agriculture-Forestry) is behind SUB (D3), just on the other side of the loading dock

SUB (Student Union Building) is near the Butterdome (the big yellow building on campus) and is facing the Van Vliet entrance of the Butterdome.

We will have signs pointing in the direction of the HNRU as soon as you enter the AgFor building.

APPENDIX D: Telephone and email scripts

CONTACTING THE POTENTIAL PARTICIPANT

Telephone script for *INITIAL CONTACT* with potential participants from *PREVIOUS STUDY REGISTRY*

Hello,

My name is _____ and I am a researcher from the University of Alberta. I got your name from a diabetes study that you participated in last year. When you participated in this project, you had indicated an interest in taking part in future related research projects.

Are you still interested? Do you have a couple of minutes?

We are currently starting a study to find out what people with T2D eat. Your participation will be a valuable contribution to research on Type 2 Diabetes and diet.

[If no]. OK. Thank you for your time. Good-bye
[If uncertain, offer to tell them more]. Would you like to know a bit more about the project? Would you like me to call you back this evening or tomorrow?
[If yes, continue]
If you think you might be interested in taking part, we will invite you to attend an information session which will take roughly ½ hour. After the session, we will have you complete a questionnaire; we will weigh you and take measurements. We will also measure your HbA_{1c}. This will take an additional 1 and a half hour or so. We will be asking our study participants to collect grocery receipts and fill out a 3 day food record in the next few weeks.

Participation is voluntary and you will be free to leave at any time if you choose. [The following is for people who seem hesitant]You may leave after or during the session, refuse to answer the questionnaire or quit any time during the study.

The information session will be a small group of 3-5 participants. We will be providing a snack at the session. After completing the study, you will have the option of receiving information about how good your diet is and information about your food cost.
Do you have any questions?
Are you interested in participating in this study?

To take part, you must

- be at least 18 years old,
- be type 2 diabetic,
- not be pregnant or breastfeeding,
- have no digestive disorders,
- be able to read, write and speak English,
- have no extreme physical disability
- have completed basic diabetes education offered through Alberta Health and Wellness
- have not previously been involved in any other lifestyle intervention study

We have a number of days and times available for the information session. They are:
Tuesdays 5:30-8:00PM ,
Wednesdays 5:30-8:00PM ,
Thursdays 10:00AM – 12:30PM, or 1:30-4:00PM
Fridays,10:00AM – 12:30PM, or 1:30-4:00PM
Saturdays 10:00AM – 12:30PM, or 1:30-4:00PM

Which of these would be a good day and time for you to attend the information session? If you are not the main grocery shopper in your household, we encourage him or her to accompany you, but that is not necessary.

Because we are measuring height and weight, it would be helpful if you brought light clothing to change into. If you do not have light shorts and a t-shirt, we will provide you with a paper gown to wear. It may also be helpful to bring a list of your medications, as we will be asking for this at the session.

If you have any questions at any time please don't hesitate to contact me. The project name is PANDA. I can give the phone # and email address if you like. The phone number is 780-248-1501. Email is **pandaresearch@med.ualberta.ca.**
We will respond within 1 day.

We have a webpage on the U of A website, if you are interested. [If asks for it] the PANDA website is:

http://www.ales.ualberta.ca/afns/PANDA.cfm

The information session will take place at the Human Nutrition Research Unit. Do you know where that is? [if participant has email] We can email you a map. [If not, ask if they know where the AgFor centre is, if not, the butterdome, SUB, HUB, hospital, etc]

Telephone script *INITIAL CONTACT* for potential participants that *CONTACT US AND LEAVE MESSAGE* either by email or telephone

Hello,

My name is _____ and I am a researcher from the University of Alberta. We received your message responding to the (ad/poster/article); thank-you for your response! We are currently starting a study to find out what people with T2D eat. Your participation will be a valuable contribution to research on Type 2 Diabetes and diet.

Are you still interested? Do you have a couple of minutes?

[If no]. OK. Thank you for your time. Good-bye
[If uncertain, offer to tell them more]. Would you like to know a bit more about the project? Would you like me to call you back this evening or tomorrow?
[If yes, continue]

If you think you might be interested in taking part, we will invite you to attend an information session which will take roughly ½ hour. After the session, we will have you complete a questionnaire; we will weigh you and take measurements. We will also measure your HbA_{1c}. This will take an additional 1 and a half hour or so. We will be asking our study participants to collect grocery receipts and fill out a 3 day food record in the next few weeks.

Participation is voluntary and you will be free to leave at any time if you choose. [The following is for people who seem hesitant]You may leave after or during the session, refuse to answer the questionnaire or quit any time during the study.

Anticipate questions

The information session will be a small group of 3-5 participants. We will be providing a snack at the session. After completing the study, you will have the option of receiving information about how good your diet is and information about your food cost.

Do you have any questions?
Are you interested in participating in this study?
To take part, you must

- be at least 18 years old,
- be type 2 diabetic,
- not be pregnant or breastfeeding,
- have no current digestive disorders,

- be able to read, write and speak English,
- have no extreme physical disability
- have completed basic diabetes education offered through Alberta Health and Wellness
- have not previously been involved in any other lifestyle intervention study

Do you meet all the eligibility criteria?
We have a number of days and times available for the information Session. They are:
Tuesdays 5:30-8:00PM ,
Wednesdays 5:30-8:00PM ,
Thursdays 10:00AM – 12:30PM, or 1:30-4:00PM
Fridays,10:00AM – 12:30PM, or 1:30-4:00PM
Saturdays 10:00AM – 12:30PM, or 1:30-4:00PM

Which of these would be a good day and time for you to attend the information Session? If you are not the main grocery shopper in your household, we encourage him or her to accompany you, but that is not necessary.

Because we are measuring height and weight, it would be helpful if you brought light shorts and a t-shirt to change into when we measure these. If you do not have light shorts and a t-shirt, we will provide you with a paper gown to wear. It may also be helpful to bring a list of your medications, as we will be asking for this at the session.

If you have any questions at any time please don't hesitate to contact me. The project name is PANDA. I can give the phone # and email address if you like. The phone number is 780-248-1501. Email is **pandaresearch@med.ualberta.ca.**
We will respond within 1 day.

We have a webpage on the U of A website, if you are interested. [If asks for it] the PANDA website is:

http://www.ales.ualberta.ca/afns/PANDA.cfm

The information session will take place at the Human Nutrition Research Unit. Do you know where that is? [if participant has email] We can email you a map. [If not, ask if they know where the AgFor centre is, if not, the butterdome, SUB, HUB, hospital, etc]
Thank-you very much for your time.

***EMAIL FOLLOW-UP CONFIRMING* contact and thanking potential participant and, if appropriate, re-stating the agreed upon date for Study Session**

Subject line: **Information Session – PANDA Diabetes Research Project**

Dear (potential participant),

My name is _____ . We spoke recently on the phone about a research project that explores what helps or stops people from following a diet good for those with diabetes.

I am writing to thank-you for agreeing to be a part of this project, and to confirm the time and date that you will be attending the information session:

Date: _____ Time: _____

Also, we will be asking you to give us a list of your medications, what condition each medicine is for and when they are taken. You might find it helpful to bring that list with you when you come to our session

I have attached directions to the Human Nutrition Research Unit. If you have any questions or concerns about directions, parking, or the project, you can call us at (780) 248-1501 or email us at **pandaresearch@med.ualberta.ca.** We will respond to messages within 1 day.

For more information on the PANDA project, visit: http://www.ales.ualberta.ca/afns/PANDA.cfm

Your participation will be a valuable contribution to research on Type 2 Diabetes and diet. Please bring light shorts and a t-shirt to change into, if possible.

Also, we will be asking you to give us a list of your medications, what condition each medicine is for and when they are taken. You might find it helpful to bring that list with you when you come to our session.

Sincerely,

PANDA Research Coordinator

***MAIL FOLLOW-UP CONFIRMING* contact and thanking potential participant and, if appropriate, re-stating the agreed upon date for Study Session**

Information Session – PANDA Diabetes Research Project

Dear (potential participant),

We spoke recently on the phone about a research project that explores what helps or stops people from following a diet good for those with diabetes.

I am writing to thank-you for agreeing to be a part of this project, and to confirm the time and date that you will be attending the information session:

Date: _____ Time: _____

Since we will be giving instructions on how to collect and send grocery receipts, we are inviting the main grocery in your household to accompany you, but this is not necessary.

I have included a map of the University of Alberta, indicating where the Human Nutrition Research Unit is located (this is NOT the where you went to participate in the diabetes project last year). If you have any questions or concerns about directions, parking, or the project, you can call us at (780) 248-1501 or email us at **pandaresearch@med.ualberta.ca.** We will respond to messages within 1 day.

Your participation will be a valuable contribution to research on Type 2 Diabetes and diet. See you on the _____ at _____ ! Please bring light shorts and a t-shirt to change into, if possible.

Also, we will be asking you to give us a list of your medications, what condition each medicine is for and when they are taken. You might find it helpful to bring that list with you when you come to our session

Telephone/email reminders
Hello, This is _____ from the PANDA Diabetes study. I'm just reminding you that you have an information session scheduled tomorrow at (time). Feel free to contact us with any questions or concerns. See you tomorrow.

Telephone script for activity recall

Hello, this is_____ from the PANDA diabetes study and I am calling to conduct the activity recall interview. Do you have 10-15 minutes?(If no, ask if it is OK to call back another day as indicated on the consent form or set up at least two possible days/times for the interview. If yes, continue).

I am going to ask you about what you did yesterday. I am not concerned about exact times of each activity, I just want to find out what you did and approximately how much time it took. I am going to ask what you did from the time you got up yesterday morning until the time you got up this morning. Also, if you are not the main meal preparer in your household, I would like to interview that person, if this is okay with you and the other person. (If yes, the same questions are asked of the main meal preparer as the participant after the interview with the participant.)

Do you have any questions before I begin? (If no, continue)

What time did you get up yesterday morning? (Record answer in book)

What did you do after you got up?

Then what did you do, etc.

Generally the participant gave the information with some prompting throughout the interviewer. Usual prompts included

- Did you prepare breakfast (or lunch, dinner, snack) yourself or did you prepare the meal for yourself? Did you prepare the meal for others? How many people did you prepare the meal or snack for? How many people ate with you or did you eat alone? How long did it take to eat the meal or snack? Did you clean up after the meal? If not, did someone else?
- How did you get to work (walk, bus, car, etc.)? How long did it take? (If the participant went out to the mall, golf course or to visit someone, the same questions were asked).
- What type of work do you do (physical, sedentary or mix of physical and sedentary). When did you take breaks? How long were your breaks? What did you do on breaks? What did you eat? Did you eat with others? Did you eat or drink anything while working. Where did you eat lunch? Did you have to walk or drive to where you ate lunch?
- What time did you get off work (or leave the golf course, etc.). Where did you go when you left work? How long did the drive (walk, bus ride) take?
- What time did you go to bed? Did you sleep through the night? Did you eat or drink anything if you got up in the night? Did you check your blood sugar during the night?
- What time did you get up this morning?

After the interview, the activity recall was recapped and anything that was left out or misinterpreted was corrected and the participant was thanked. Reminders to begin the food record or to send receipts or food record were given (if participant was scheduled to do so within the following few days). The team member also asked if there were any questions or concerns before hanging up.

APPENDIX E: The information session presentation

Script for information session powerpoint presentation

INTRODUCTION TO THE PANDA STUDY

[we will have all questionnaires at the table with pens in the order that we will go over them. We will be handing out the information sheets and informed consent as they arrive]

[We will have powerpoint presentation ready to go on slide 1 (intro slide)]

[The presentation begins] Please take a copy of the information sheet and 2 copies of the consent form. You can begin to read through this as we wait for everyone to come. If there are any questions, feel free to ask.

Hello everyone, and welcome to PANDA.

I would like to thank every one of you for coming out today and for becoming a part of this project. We appreciate your cooperation.

My name is Denise. I am an M.Sc student in Agr. and Resource Economics working on the PANDA project; I am working with Gayathiri, an M.Sc. Student in Nutrition and Jeanie, the PANDA project coordinator. We are going to tell you about the project that you are here to be part of, and to guide you through the instructions and protocols for this part of our study. If you have any questions along the way, please let me know and I will do my best to answer them for you.

Slide 1 – (introduction slide) This project is part of a larger project, called PANDA. PANDA stands for *physical activity and nutrition for diabetes in Alberta*.

Slide 2 .For this branch of the PANDA project, Dr. Cathy Chan is the principal investigator. The co-investigators are Dr. Rhonda Bell; Dr. Sven Anders, and Dr. Sean Cash

Slide 3 Purpose

Our goal is to promote healthy behaviours in Alberta, which include healthy eating and getting enough exercise. We are focusing on people with T2D living in the Edmonton area. We need 60-85 participants for the study. If you would like more information about the study, we will be more than happy to talk with you about it.

Slide 4.

Here is the outline. This is what we will be doing today and what we would like you to do at home.

Today you will be completing the consent form and questionnaire.

Then we'll have each of you come to another room and we'll **measure your height, weight, waist circumference and hip circumference, and we'll take a**

small blood sample and measure your hemoglobin A_{1c}. We think all this will take approximately 2 hours.

Over the next month, we would like you to complete a 3 day food record and collect grocery receipts. We will be giving you an addressed, pre-paid envelope to return these to us. You will also be asked to answer a telephone activity questionnaire.

Slide 5

We'll go over **the information sheet** and ask you to sign the consent forms first.

Please have in front of you the **'information sheet'**. [show a copy to the group]. I will go over this now. If you have any questions, you can ask at any time.

The information sheet is yours to keep. It has contact information on it as well as information about the project.

The number of people with type 2 diabetes is increasing steadily in Canada. A balanced diet is very important for diabetics. We are trying to find the reasons that either help or stop people with Type 2 diabetes from staying with their diet. The goal of PANDA is to create diet and physical activity programs that are easy to follow and simple to understand.

We have already given you a summary of the procedure and the purpose. If you have any questions or comments, feel free to ask at any time.

Confidentiality

You will be given an identification number – this is how we will identify you. Except for people working on the PANDA project, no one will have access to your name, contact information or any of the information you give to us – all this will be kept in a locked filing cabinet. Your name will never appear on any report.

Risks and benefits

There are no known risks for participating in this study. It will take time for you to fill out the questionnaire, collect grocery receipts, and keep your dietary records.

If you wish, you can receive information about your diet and the cost of your food from the study coordinators.

Participation in the study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time.

Please fill out the consent form, if you haven't already done so. Be sure to sign and date at the bottom. Ask questions if something is not clear. There are 2 copies of the form – one you sign, date and give to us and the other you can keep.

[give everyone a couple of minutes, then collect them. Count them to **ensure that everyone has handed them in**]

Slide 6

First, I will talk about is the **28 day grocery receipt collection**. [Hold up sheet] We are interested in learning about how activities related to food impacts the lives of diabetics. To answer this, we must know how much money is spent on groceries and on food away from home.

Envelopes have been provided for the purpose of keeping your receipts [show envelope]. We are asking you to keep your envelope in a place where it can easily be seen when you enter your house. We will be asking you to mail in the receipts every Monday (or whatever day)? to the address on the envelope.
We have also provided you with a pen and a fridge magnet [hold these up] so that you can keep track of your activities and to give yourself reminders.
We will be sending weekly reminders to send your receipts
If you have any questions or concerns, do not hesitate to contact us.

We are suggesting that you keep the envelopes in a place where they can be easily seen.

Slide 7

When you return from a grocery shopping trip, place your receipt or receipts into the envelope.

Slide 8

If dining out, please circle the meal and beverages that you have paid for. Please use ink for this.

Slide 9

We are only interested in your food and beverage purchases, so you can block out any irrelevant information, such as credit card information. I know you buy more than just food at the grocery store. You don't have to block out everything that is non-food, like soap and toothpaste – we will do that at the office. Only block out items if you want to.

Slide 10

If you have no receipt, use the notebook to write down information normally on the receipt:

Slide 11

Here is an example of a cram dunk 'receipt'. Store name and location, Items, Cost and date.

Slide 12

Now we will move on to the **activity recall**
We will call you at a convenient time. This is what we will be asking you when we call you – we will do that during the next week. This is an example of a morning recall. We will be guiding you through the process, so I will not go into details about it here. We want to know only your activities and the person who is **primarily responsible for meal preparation,** if this is not you. [do not discuss the table – just show on the ppt slide- unless there are questions]

Slide 13

Now I will go over the **3 day food records**. [make sure everyone has this front of them. Hold up a copy] We will now discuss the nutrition section of the study.

If you have any questions while you are filling this out please contact us. You can also interrupt us at any time during this presentation.

This is a Three- Day Dietary Intake Record – to be filled out for 2 weekdays and 1 weekend day. So, that means Thursday, Friday and Saturday or Sunday, Monday and Tuesday. Unlike the grocery receipts, this is just for the participant. If your child eats Cheerios every morning for breakfast and you never eat them, do not write it down in your record.

Slide 14

Each day is broken up into 6 eating times – 3 meals and 3 snacks, each is on a separate page.

Slide 15

Here is a sample record. A completed meal record will look something like this. Please turn to that sheet in your 3 day food record, the 3rd sheet

- Please record EVERYTHING you drink and eat
- do not change your normal eating habits during those three days.
- Record all foods eaten at home and those eaten away from home, as soon as possible after it is eaten.

You may have done something similar to this at some point and it may or may not have required much detail. This is a research project in which we are going to require attention to fine detail. We are asking you to record every possible piece of information about the products you eat over the 3 days.

In this example, we have included both the metric and imperial measurements, but you can use whichever you feel comfortable with. There is no need to use both. When recording at home meals and snacks, be careful. Do not use bowl or plate. [show 2 different sized bowls]. There are several sizes of bowls and we will not know which size you are referring to. If you have measuring utensils (cups and spoons [show these]), use these to measure how much you are putting in your bowl or on your plate.

Slide 16

Please look under the **food and beverage column**.That's the 1st column. Here is where you enter all foods and beverages consumed at the meal or snack time. This is an example for spaghetti. You would do the same for stews, other pasta dishes, foods containing sauces, etc). Please record the specific type of food (for example: whole wheat bread, frosted flakes cereal). Include anything added at the time of eating (for example: sugar, syrup, jam, butter, mayonnaise, gravy, milk, salt). Do not forget to include cream and sugar in coffee or tea if used. Here they listed the dish and underneath they listed everything in the dish.

Slide 17

For the 2nd column, Include

- Brand and flavor – in this example they say Hunt's, Kraft. They use garlic flavour.

- Method of cooking, for example boil, bake, fry, steam. Remember to record the amount of oil used in cooking, along with the brand and type of oil or butter. Include all other relevant information included on food label (low fat ranch salad dressing, 28% M.F. (milk fat) cheddar cheese, lean ground beef). For processed foods, you could provide **food labels or box-tops**, if available. **Please provide recipes** for home-made foods. If you don't have an exact recipe, estimate as close as possible and tell us what fraction of a batch you have eaten (for example – 1/5 of a batch of beef stew).
- Include details such as chicken BREAST, beef RIBS, pork CHOPS

Slide 18

The 3rd column is for how many cups, tablespoonfuls, ounces (or grams) or pieces and write the actual measure like cup, tablespoon, etc. This also applies to both the food and added items

Slide 19

- For meals eaten in restaurants, include these things:
  - Name of restaurant
  - Dish you have eaten
  - Everything that you have told the waitstaff – this means answers to questions like types of sauces, size of dish, or any other option or choice that is given. If we do not have this information there is no way for us to determine the nutrient content of your meal. This applies to both the dish and what has been added to it.
  - Include lists of ingredients if possible. Some restaurants do not supply this, although most chains do. If you cannot get this information, just record as much as you know – maybe a roast beef dinner (3 oz beef) with gravy (2 tablespoons), mashed potatoes (1/2 cup, with 1 teaspoon butter) and asparagus (2/3 cup, boiled). Added 1/10 teaspoon salt to meal.
  - Do not forget to write down the name of the restaurant and the dish.

Slide 20

In this example, the participant has a bowl of Tim Horton's chicken noodle soup. Here is what you would record. [show slide]

Slide 21

In this example, the participant has ordered a ham and swiss sandwich from Tim Horton's. The sandwich artist asks if you want while or whole wheat bread, do you want cheese on your sandwich and do you want tomato, lettuce, onion, etc. They also ask if you want mustard or mayo. You must record this (and the amounts) on your sheet.

Coffee orders at Tim Horton's are standard – such as double cream. But if you are adding your own milk, cream, sugar or sweetener to something, you must estimate or if possible, measure, the amount you are adding. For example 2 tablespoons of cream. Don't forget to include the size of the coffee. If possible, you could tell us if the coffee or tea is light, medium or dark along with an estimate of what you have added.

Slide 22

I would like to explain a little bit more about the information we would like you to include. Here is an example of a product called hempmilk. Under description of item, you would write the brand name (living harvest), the flavour (vanilla) and other information that might vary with this product. For example unsweetened.

Slide 23

Here is another good example – the brand name, the style, organic, plain, non-fat. These would all be listed under description of item.

Slide 24

If there is a label on the package, you can remove it and send it to us with your food record. You can also do this with chip bags and wrappers from bars.

Slide 25

For items such as fruit, just tell us what the fruit is, the variety, such as Granny Smith and whether it is small, medium or large.

We have also given you a sheet to use a guide in determining a portion size [hold up]. This will be helpful in determining how large your portion size is.

Slide 26

For products such as juice, we need to know whether or not it is actually juice or a flavoured drink or mix. If it is juice, is it 100% juice or less than that? You should also include whether it is fresh juice or frozen concentrate. Also record if anything has been added, such as calcium and vitamin D in this orange juice.

Slide 27

Remember to record everything Include as much information as possible including quantities and added items. In this example, it looks like a dagwood sandwich: 3 slices of rye bread, 2 oz deli sliced ham, 2 oz deli sliced turkey breast, 3 tablespoons chopped red onion, 4 lettuce leaves, 4 thin slices tomato, 2 tablespoons mustard, (specify brand of each of these) and dash of salt and pepper

Slide 28

In the space provided at the bottom, list any vitamin or mineral supplements and/or herbal products taken, including quantities and detailed label information, indicate the time and place of your meal or snack. Please place a check mark on skipped meals snacks and record the times of 2 or more snacks or meals [show this]. If you can, provide the DIN #. Some products do not have this. This ferrous sulfate bottle has a DIN # [show this]. It there is a DIN #, it will look like this. [hand out to participants to look].

Slide 29

Now, a little practice.

We have prepared a snack for you [show snack display]. Suppose you have eaten a juice, a small pack of crackers with this cheese dip, and a banana. I have a blank afternoon snack sheet from the food record for you. What I would like you to do is record this snack on the food record. Remember, you are allowed to ask questions. To reward yourself for this, please help yourself to the snacks! [give a few minutes, more if needed. Answer questions. Treat this like a short break - do not rush participants here; they have absorbed a lot in a really short time!!]**.**

Slide 30

Thanks! We appreciate your honesty. It is crucial to the success of this research study.
[end powerpoint presentation]

[As they return, another person can go to the next room for their measurements]. If there are any questions at any time, please ask.
[give time for measurements and questionnaires. Someone is in room throughout the process]
We are now finished the session. Before you leave, are there any questions about what you have to do? [about 5-10 seconds]. OK. It's been a pleasure working with you. Thank you for your time.

APPENDIX F: Information sheet

INFORMATION SHEET

Title of Project

Cross-sectional study of dietary intake, time use, and perceived food availability, acceptability, and accessibility for people with Type 2 diabetes.

Principle Investigator:
Dr. Cathy Chan 780-492-7742
Cathy.Chan@ualberta.ca
Co-investigators
Dr. Rhonda Bell 780-492-7742
Rhonda.Bell@ualberta.ca
Dr. Sean Cash 608-262-5498 scash@ualberta.ca
Dr. Sven Anders 780-492-5453
Sven.Anders@ualberta.ca

Purpose

The purpose of this study is to assess your dietary intake and to find out what helps or stops people with Type 2 diabetes from following a diabetic diet. We are doing this study for 2 reasons. First, we will use this information to help us develop a new nutrition program that will be part of a larger study called Physical Activity for Nutrition and Diabetes in Alberta (PANDA). The second reason is that we think we will use some of the same questionnaires and methods in the PANDA project and in this project. Therefore we need you to try them out. We will also ask you questions about methods that you will use (e.g. How easy was it for you to collect grocery and food receipts for 28 days?). The goal of PANDA is to create diet and physical activity programs that are easy to follow and simple to understand, and the current study is one step toward this goal.

Background

The number of people with type 2 diabetes is increasing steadily in Canada. Diet is considered one of the major treatments to help control blood sugar levels. Though various dietary guidelines have been developed many people seem to find it difficult to follow the diet that is best for treating diabetes. We need to find the reasons that either help or stop people with Type 2 diabetes from staying with their diet.

Procedure

- If you agree to participate in the study you will be asked to come to HNRU (Human Nutrition Research Unit) located at Agricultural, Food and Nutritional science department of University of Alberta and to complete the questionnaires about your food purchases, the foods you eat, and the cost of foods you purchase.

- You will also be asked some questions about your age, ethnicity, income level and other general information.

- Completing the questionnaire might take approximately 45 minutes.

- During a meeting with the study coordinator, you will be asked to have your Hemoglobin A_{1c} level (a test that measures your long term blood sugar control) measured and to have height, weight, waist and hip circumference measured.

- For the Hemoglobin A_{1c} measurement, you will need to prick your finger using a clean lancet (i.e. just like when you do your blood sugar check at home).

- The study coordinators will explain how to fill out a 3 day food record, an activity recall, and information about collecting and saving your grocery receipts and restaurant receipts.

- You will be asked to return records and receipts to us by mail in pre-paid envelops that will be given to you.

Confidentiality

Only people associated with the research study (Investigators and the study coordinators) will have access to your records. Records from the study are confidential and will be securely stored in locked filing cabinets for five years, after which they will be destroyed. Your records will be listed according to your identification number rather than your name. Published reports resulting from this study will be summarized as group findings. We will not identify you in our report. We will not give your name or phone number to anyone or use them for any other purpose apart from the study. Other participants may know that you took part in the study, but they will never see your questionnaires or study information.

Risks and Benefits

There are no known risks for participating in this study. It will take time for you to fill out the questionnaire, collect grocery receipts, and keep your dietary and time records. You may get a sore finger from the finger prick blood sample taken to determine your HbA_{1c}. This should be minor because the test is the same as the finger prick that you do to test your blood glucose.

If you wish, you can receive information about your diet compared with Canada's Food Guide and diabetes recommendations and some information about the cost of your food from the study coordinators. The study coordinators will do their best to answer any questions that you have about diabetes research and related questionnaires.

Participation in this survey will help the researchers to better understand many factors that could either help or stop people with Type 2 diabetes from following a diet that is recommended to treat this disease.

Withdrawal from the study

Participation in the study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time.

We will be calling you by telephone to ask you some questions about grocery shopping, preparing food, and other things.

If you have any concerns about your rights to participate as a subject in this study, you may contact the University of Alberta Health Research Ethics Board at780-492-0302.

APPENDIX G: Consent form
CONSENT FORM

Title of Project: Cross-sectional study of dietary intake, time use, and perceived food availability, acceptability, and accessibility for people with Type 2 diabetes.

Principal Investigator: Dr. Cathy Chan	Phone Number(s):780-492-9939
Co – Investigators(s)	Phone Number(s):
Dr. Rhonda Bell	780-492-7742
Dr. Sean Cash	608-262-5498
Dr. Sven Anders	780-492-5453

	Yes	No
Do you understand that you have been asked to be in a research study?	☐	☐
Have you read and received a copy of the attached Information Sheet?	☐	☐
Do you understand the benefits/risks involved in taking part in this research study?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Do you understand that you are free to withdraw from the study at any time, without having to give a reason?	☐	☐
Has the issue of confidentiality been explained to you?	☐	☐
Do you understand who will have the access to your PANDA study records?	☐	☐

How do you prefer to be contacted with reminders about collecting and returning your grocery receipts and 3 Day Food Record?

- ☐ Email reminders
- ☐ Telephone message reminders
- ☐ Both
- ☐ Doesn't Matter

Email address_____

Telephone number_____

Address_____

_____

_____

Which day and what time would be the best day and time for us to contact you? Please put a checkmark beside the best day and write in the best time to contact you

- ☐ Monday Time _____
- ☐ Tuesday Time _____
- ☐ Wednesday Time _____
- ☐ Thursday Time _____
- ☐ Friday Time _____
- ☐ Saturday Time _____
- ☐ Sunday Time _____

Feedback

Would you like to have feedback on your diet?

Yes No

APPENDIX H: The questionnaire (coded)

DEMOGRAPHIC QUESTIONNAIRE

Missing value-999

Please write or mark the appropriate answer for the following questions.

Date: _____

Age: _____

Gender: Male **=0** / Female **=1**

Years with diabetes diagnosis: _____

Ethnicity:

Please circle the appropriate answer(s).

Latin American Japanese

Chinese

Other

West Asian Afghan Iranian

First Nations Metis or Inuit

South Asian East Indian Pakistani Sri Lankan

Southeast Asian Cambodia Indonesian Laotia Vietnamese

Education:

Please put a checkmark in the box

- ☐ Less than high school **=1**
- ☐ High school graduate **=2**
- ☐ Some college or university (have some post secondary education, but not completed) **=3**
- ☐ College **=4**
- ☐ University graduate **=5**
- ☐ Above **=6**

***Employ*ment**

- Wages and salaries **=1**
- Income from self-*employ*ment**=2**
- Retirement income (pensions, old age security and GIS, etc.**)=3**
- Un*employ*ed (not including retirement**)=4**
- Other (**)=5**
- Income from self-*employ*ment + Retirement income **=6**
- Wages and salaries + Income from self-*employ*ment **=7**
- Wages and salaries + Retirement income **=8**

Household annual income:

Number of people in the household: _____

- ≤ $ 20,999 **=1**
- $ 21,000 to $39,999 **=2**
- $ 40,000 to $ 59,999 **=3**
- $ 60,000 to $ 79,999 **=4**
- $ 80,000 to $ 99,999 **=5**
- $ 100,000 to $ 119,999 **=6**
- ≥ $ 120,000 **=7**

GENERAL HEALTH AND DIABETES TREATMENT QUESTIONNAIRE

Diabetes Treatment:

- ☐ Lifestyle (Diet + Exercise**) =1**
- ☐ Lifestyle + oral antidiabetic drugs **=2**
- ☐ Lifestyle + *insulin* **=3**
- ☐ All **=4**

Please list all medications you take on a regular basis:

Categorise as *insulin*, diabetes medication and others

MEDICATION	CONDITION IT IS USED FOR	FREQUENCY	DOSE	BEFORE /AFTER FOOD

Have you been diagnosed by a doctor as having… (Please check that all apply)
Yes = 1(if circled), No=0 (if not circled)

A	Heart trouble	K	Allergies
B	Cancer	L	Trouble hearing
C	Chronic asthma, emphysema, or bronchitis?	M	Trouble seeing
		N	Bladder control difficulties
D	Osteoporosis	O	Balance problem or frequent falls
E	Arthritis		
F	High blood pressure	P	Burning foot
G	High cholesterol	Q	Poor appetite
H	Hepatitis	R	Kidney problems
I	Back problem	S	Other health problems
J	Foot problems		

Are you a… (Please check one)

- ☐ Current, regular smoker **=1**
- ☐ Occasional smoker **=2**
- ☐ Former smoker **=3**
- ☐ Non-smoker **=0**

SELF-CARE ACTIVITIES AND DIABETES TREATMENT QUESTIONNAIRE

Yes=1(if circled), No=0 (not circled)

Circle all the appropriate response(s)

1. Which of the following has your health care team (doctor, nurse, dietitian, or diabetes educator) advised you to do?

a. Follow Canada's Food Guide
b. Follow a complex carbohydrate diet or a low glycemic index diet
c. Reduce the number of calories you eat to lose weight
d. Eat foods high in dietary fiber
e. Eat lots (at least 7 servings per day) of fruits and vegetables
f. Eat very few sweets (for example: desserts, non-diet sodas, candy bars)
g. Avoid foods high in fat (especially trans-fats from hydrogenated sources and saturated fats)
h. Other (specify):
i. I have not been given any advice about my diet by my health care team.

2. Which of the following has your health care team (doctor, nurse, dietitian or diabetes educator) advised you to do?

a. Get regular physical activity (such as walking) on a daily basis.
b. Fit physical activity into your daily routine (for example, take stairs instead of elevators, park a block away and walk, etc.)
c. Exercise continuously for at least 30 minutes at least 5 times a week.
d. Engage in a specific amount, type, duration and level of exercise.
e. Other (specify):
f. I have not been given any advice about exercise by my health care team.

3. Which of the following has your health care team (doctor, nurse, dietitian, or diabetes educator) advised you to do?

a. Test your blood sugar using a drop of blood from your finger and a color chart.
b. Test your blood sugar using a machine to read the results.
c. Test your urine for sugar.
d. Other (specify):
e. I have not been given any advice either about testing my blood or urine sugar level by my health care team

4. Which of the following medications for your diabetes has your doctor prescribed?

a. An *insulin* shot 1 or 2 times a day.
b. An *insulin* shot 3 or more times a day.
c. Diabetes pills to control my blood sugar level.
d. Other (specify):
e. I have not been prescribed either *insulin* or pills for my diabetes

Physical Activity Adherence

Considering a **7-Day period** (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes.**

Questions A to D enter number of times per week

Times Per Week

A. STRENUOUS PHYSICAL ACTIVITY
(heart beats rapidly, sweating)

(e.g., running, jogging, hockey, soccer, squash, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling, vigorous aerobic dance classes, heavy weight training)

B. MODERATE PHYSICAL ACTIVITY
(not exhausting, light perspiration)

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

C. MILD PHYSICAL ACITIVITY
(minimal effort, no perspiration)

(e.g., easy walking, yoga, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, snowmobiling)

Considering a **7-Day period** (a week), how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

1. Often=**2** 2. Sometimes=**1** 3. Never/rarely=**0**

DIETARY ADHERENCE QUESTIONNAIRE

Please Circle the best answer.

The questions below ask you about your diabetes diet activities during the past 7 days. If you were sick during the past 7 days, please think back to the last 7 days that you were not sick.

Questions 1 to 12 0=0 1=1 2=2 3=3 4=4 5=5 6=6 7=7

1. How many of the last SEVEN DAYS have you followed a healthful eating plan such as Eating Well with Canada's Food Guide with appropriate serving sizes?

   0 1 2 3 4 5 6 7

2. On average, over the past MONTH, how many WEEKS have you followed your eating plan for diabetes?

   0 1 2 3 4

3. On how many of the last SEVEN DAYS did you eat the number of fruit and vegetable servings you are supposed to eat based on Canada's Food Guide (women aged19 – 50: 7–8 servings; males aged 19 – 50: 8 – 10 servings; women and men over 50: 7 servings)?

   0 1 2 3 4 5 6 7

4. On how many of the last SEVEN DAYS did you eat carbohydrate-containing foods with a low Glycemic Index? (Example: dried beans, lentils, barley, pasta, low fat dairy products)

   0 1 2 3 4 5 6 7

5. On how many of the last SEVEN DAYS did you eat foods high in sugar as cakes, cookies, desserts, candies, etc.?

   0 1 2 3 4 5 6 7

6. On how many of the last SEVEN DAYS did you eat foods high in fibre such as oatmeal, high fibre cereals, whole grain breads?

   0 1 2 3 4 5 6 7

7. On how many of the last SEVEN DAYS did you space carbohydrates evenly throughout the day?

0 1 2 3 4 5 6 7

8. On how many of the last SEVEN DAYS did you eat fish or other foods high in omega-3 fats?

0 1 2 3 4 5 6 7

9. On how many of the last SEVEN DAYS did you eat food which contained or was prepared with canola, walnut, olive, or flax oils?

0 1 2 3 4 5 6 7

10. On how many of the last SEVEN DAYS did you eat foods high in fat (such as high fat dairy products, fatty meat, fried foods or deep fried foods)?

0 1 2 3 4 5 6 7

11. On how many of the last SEVEN DAYS did you consume any alcohol?

0 1 2 3 4 5 6 7

12. On how many of the last SEVEN DAYS did you consume red wine?

0 1 2 3 4 5 6 7

FOOD ACCEPTABILITY QUESTIONNAIRE

Please circle the appropriate response

Food acceptability refers to foods that are personally and culturally acceptable to you. For example, are the foods recommended in a diet for Type 2 diabetes those that you want to eat?

1. In thinking about the foods that are part of a diet that you follow for your diabetes, how likely is it that you will regularly eat these foods?

Very unlikely= -1 Neutral=0 Very likely=1

2. When choosing to buy foods that you prepare at home, how often do you choose foods that are part of a diet that you follow for your diabetes?

Never=0 Seldom=1 Usually=2 Often=3 Always=4

3. When you choose foods that are **NOT** part of your recommended diet, what are the main 3 reasons for this?

Reason
1_____

_____

Reason
2_____

_____

Reason
3_____

4. Since you were first diagnosed with diabetes, has your enjoyment of foods that are part of your recommended diet:

Decreased=-1 Stayed about the same =0
Increased=1

5. Since you were first diagnosed with diabetes, has the frequency of eating food away from home:

Decreased=-1 Stayed about the same =0
Increased=1

6. How many days out of the week do you enjoy the foods that are part of your recommended diet?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7

7. How many days of the week do you find yourself seeking out foods that are **NOT** part of your recommended diet?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7

8. How many days of the week do you eat foods that are part of your ethnic heritage?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7 N/A=0

9. How many days of the week do you eat foods that are **NOT** part of your ethnic heritage?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7 N/A=0

10. Has this changed since you were diagnosed with diabetes?

Yes=1 No=0 Don't know=88 N/A=0

11. How many days of the week do you eat foods that are part of your recommended diet that you would rather not eat?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7

12. Do you eat foods that are produced locally (i.e. grown or produced in Alberta)?

Yes=1 No=0 Don't know=88

13. Do you believe those foods produced locally in Alberta are more diabetes friendly than those from elsewhere?

Yes=1 Neutral=0 No=-1 Don't know=88

14. Provide a list of the foods that you eat that are part of your diet for treating your diabetes and that are produced locally. Be as specific as possible.

Information about Your Recommended Diet

15. From the information you have received about your diabetes diet, is it clear to you:

What kinds of foods will be most beneficial for you?	Yes =**1**	No =**0**
What kinds of foods to avoid?	Yes =**1**	No =**0**
How often you should eat?	Yes =**1**	No =**0**
Which foods to keep handy for snacks?	Yes =**1**	No =**0**
Which foods are helpful on a sick day?	Yes =**1**	No =**0**
The glycemic index of foods that you eat	Yes =**1**	No =**0**
Foods which fill you up	Yes =**1**	No =**0**

ACCESSIBILITY TO FOOD AND FOOD RESOURCES

Accessibility refers to "the physical and economic access to foods for all, at all times".

The following questions ask you about convenience, ease of transportation to outlets, availability of foods for your diabetes, the cost of foods compared to non-diabetic diet and time preparing meals.
Food resources include: retail food stores (grocery stores, convenience stores, discount food stores or club stores (e.g. Costco)), farmers' markets, food cooperatives and anywhere that you would regularly shop for foods.

For each question, please circle the best one that applies.

Location and Convenience of Food Resources

1. Are there places where you buy foods that are right for your diabetes close to where you live?

Yes=**1** No=**0**

2. Are there places where you buy foods that are right for your diabetes close to where you work?

Yes=**1** No=**0** NA=**99**

3. How far do you travel to buy food?

_____ miles or _____ km ***must be converted**

To KM
1.6 km = 1 M

4. How many different stores do you go to, to buy the foods you need for a week?

a. 1-2 **=1**
b. 3-4 **=2**
c. 5-7 **=3**
d. More than 7 **=4**

5. Where are groceries usually purchased for you and your family? (Check all that apply)

1 = Chain supermarket (Safeway, Sobey's, Superstore, etc.)
_____

2 = Independent grocery store (Planet Organic, Wild Earth, etc)
_____

3 = Farmer's Market or similar
_____

4 = Other (please specify)_____

6. Are there food items in your diet plan that are not available at your regular grocery store?

Yes = **1** No = **0** I don't know = **88**

7. How long does it take for a typical shopping trip, including commuting time? If you shop at more than one store, include time for each store, and include both shopping and commuting time.

Hours_____ minutes_____* **Total minutes per trip Hrs x 60**

8. If there are items in your diet plan that you don't buy at your regular grocery store, what do you do?

a. Not buy them at all **If Yes = 1, No = 0 (no is not circled)**
b. Go to another store **If Yes = 1, No = 0 (no is not circled)**

i. If you go to another store, over SEVEN DAYS, how often do you go to another store?
0 =**0** 1 =**1** 2 =**2** 3 =**3** 4 =**4** 5 =**5** 6 =**6** 7=**7**

c. Other (be specific) _____ *** Yes = 1, No =0 (not circled)**

9. Do the food resources you use regularly have:

Convenient store hours for you? ***If Yes = 1, No = 0** Yes No

Good customer service? * **If Yes = 1, No = 0** Yes No

Information that you can use to help you with your diet for diabetes? Yes No

10. Aside from grocery stores, convenience stores, discount stores/club stores, farmers' markets, and food co-ops, are there other places that you go to for food on a regular basis? Include food outlets that you go too often (e.g. eating lunch at a work cafeteria or Tim Horton's for breakfast on Saturdays)

Yes **=1** No = **0**

If yes, describe the situation:

Eating occasion _____

Place or food outlet _____

Transportation

11. When you go grocery shopping, how do you get there?

Private car **=1** Public Transportation **=2** Other (be specific)**=3**_____

12. Do any of the stores you shop at for groceries offer delivery service?
Yes **=1** No **=0** Don't know **=88**

Food Costs
13. Please indicate whether you spend the **same, less or more** on the following foods compared with a non-diabetic diet

Food Group	Less **=1**	Same **=2**	More **=3**	Not sure =**88**
Vegetables **=A**				
Fruit =**B**				
Meats =**C**				
Meat Alternates **=D**				
Grain Products =**E**				
Dairy Products **=F**				

Grocery shopping patterns and time use

14. Who is the MAIN grocery shopper in your home? If shared, circle all applicable

You **=1** Spouse **=2** Parent =**3** Roommate **=4** Other= **5** Not applicable **=99**

15. How often in the past month have you prepared a grocery list?

0 **=0** 1 =**1** 2=**2** 3 **=3** 4=**4** 5=**5** 6 **=6** 7 **=7** 8 **=8** 9 **=9** 10 **=10** More than 10 **=11**

16. How often in the past month has another family member prepared a grocery list?

0 **=0** 1=**1** 2 =**2** 3 **=3** 4 **=4** 5=**5** 6 **=6** 7 **=7** 8 **=8** 9 **=9** 10 **=10** More than 10 =**11** Don't know**=88**

17. How long (minutes) did it **typically** take to prepare the grocery list?

Less than 10 **=1** 10-20 **=2** 21-30 **=3** 31-40 **=4** 41-50 **=5** 51-60 **=6** More than 60 **=7** Not applicable =**99**

18. Is there a separate shopping list for the foods or ingredients you eat for your diabetes?

Yes **=1** No =**0**

19. How often in the past month have you or someone in your household gone grocery shopping?

0 **=0** 1 =1 2 **=2** 3 **=3** 4 **=4** 5 **=5** 6 **=6** 7 **=7** 8 **=8** 9 **=9** 10 **=10** More than 10 **=11** Don't know **=88**

FOOD AVAILABILITY QUESTIONNAIRE

Food availability refers to the variety of food available in retail stores.

1. Are the foods that you would like to eat to follow a diet that is best for your diabetes are readily available in your regular grocery store?

Yes =**1** No =**0** Don't know =**88**

2. Are these foods easy to find in the stores that you go to?

Yes =**1** No =**0** Don't know=**88**

3. Do the stores where you buy these foods carry a wide variety of foods?

Yes =**1** No =**0** Don't know =**88**

4. Think about the 1 or 2 stores that you go to most often to buy food. Which of the foods listed below can you buy at these stores?

Fresh Meat	Yes =**1**	No =**0**	Don't know =**88**
Processed Meat	Yes =**1**	No =**0**	Don't know =**88**
Fresh Poultry	Yes =**1**	No =**0**	Don't know =**88**
Fresh seafood	Yes =**1**	No =**0**	Don't know =**88**
Packaged meat	Yes =**1**	No =**0**	Don't know =**88**
Fresh fruits and vegetables	Yes =**1**	No =**0**	Don't know =**88**
Dairy products	Yes =**1**	No =**0**	Don't know =**88**
Eggs	Yes =**1**	No =**0**	Don't know =**88**
Cereals	Yes =**1**	No =**0**	Don't know =**88**
Bakery products	Yes =**1**	No =**0**	Don't know =**88**
Ready to eat foods	Yes =**1**	No =**0**	Don't know =**88**
Other foods	Yes =**1**	No =**0**	Don't know =**88**

5. How did you find out about where to find these foods? Example: Dietitian, Internet, friends. Please be as specific as possible.

FOOD-RELATED TIME USE QUESTIONNAIRE
for DIABETICS AND HOUSEHOLD MEMBERS

Instructions:
Please answer all questions. If your answer is zero, please answer like this:
Hours__0___Minutes__0___

If your answer is 1 ½ hours, please answer like this:
Hours__1___Minutes__30___

If you don't know the answer, please answer like this:
Don't know___X_____

*For the purpose of this study**, household** is defined as those living in the **same household** and **eating together regularly***

Food from home
The following questions apply to meals and snacks PREPARED AT HOME. This includes meals prepared and eaten at home, and food PREPARED at home and eaten away from home, such as sandwiches and salads that you have prepared to take for lunch at work.

1. How much time (total) do you **typically** spend preparing meals for you and/or your household in ONE DAY?

Hours_____ Minutes_____ ***Total Minutes**

2. How much time (total) do other household members **typically** spend preparing meals for you and/or your household in ONE DAY?

Hours_____ Minutes_____ ***** **Total Minutes** Not Applicable____**=99**

3. Do you have different meals/snacks than the rest of your household due to your diabetic needs?

Yes **=1** No **=0** Not applicable **=99**

4. If yes, how much LESS or MORE time (total) (circle appropriate response) does it **typically** take to **prepare** your meals/snacks in ONE DAY?

Hours_____ Minutes_____ ***** **Total Minutes** Don't know_____ **=88**

5. Were your meal preparation activities in the last seven days typical?

Yes **=1** No **=0**

If not, briefly explain what was different:_____
6. How much time (total) do you spend eating meals and snacks in ONE DAY?

Hours_____Minutes_____ *** Total Minutes**

7. On a typical day, compared to other members of your household, is the time you spend eating

Less **=1** Same **=2** More **=3** Not sure **=88** Not Applicable =**99**

8. If different from your household, by how much in ONE DAY?

Hours_____Minutes_____ *** Total Minutes**

9. Do you feel that you have enough time to prepare and enjoy meals and snacks appropriate for your diabetes?

Yes **=1** No **=0**

10. How many people eat regularly in your home?
Number of children (under 18 years of age)_____ Number of adults_____

Food away from home:
The following questions apply to meals and snacks PURCHASED AWAY FROM HOME. This includes restaurant meals, take-out meals and convenience store snacks. DO NOT include food PREPARED at home and consumed away from home (such as sandwiches and salads that you have prepared to take for lunch at work).

1. In the past SEVEN DAYS how often have you eaten meals/snacks away from home?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 10=10 More than 10=11
2. In the past SEVEN DAYS, how much time (total) have you spent at restaurants/diners/etc., including commuting time? (if applicable)

Hours_____Minutes_____

3. In the past SEVEN DAYS how often have you eaten meals/snacks away from home with members of your household?

0 =0 1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9
10=10 More than 10 =11

4. In the past SEVEN DAYS, how much time (total) have you spent at restaurants/diners/etc. with members of your household, including commuting time? (if applicable)

Hours_____Minutes_____ in Total minutes

5. Do you feel that constraints make it impossible for you to enjoy meals and snacks away from home appropriate for your diabetes?

Yes =1 No =0

6. Do you feel that constraints make it impossible for you to enjoy meals and snacks away from home appropriate for your diabetes with members of your household?

Yes =1 No=0 Not Applicable=99

Time use for non-food related activities:

On a **typical workday**, how much time do you spend on the following?
For example, if you usually spend 3 ½ hours watching TV, you would write 3 hours and 30 minutes.
Place a check mark under N/A if not applicable. *__Total minutes__

Activity	**Hours***	**Minutes***	**N/A=0**
Part-time work (including volunteer)			
Full-time work (including volunteer)			
Watching TV/ Using a computer (other than at work)			
Reading			
Relaxing			
Exercise/working out			
Time with children (homework)			
Time with children (sports) *Do not include activities already mentioned in Exercise/working out*			
Time with children (playing games)			
Other activity (specify)			
Other activity (specify)			
Other activity (specify)			

On a **typical weekend day**, how much time do you spend on the following?
For example, if you usually spend 3 ½ hours watching TV, you would write 3 hours and 30 minutes.
Place a check mark under N/A if not applicable ***total minutes**

Activity	**Hours***	**Minutes***	**N/A=0**
Part-time work (including volunteer)			
Full-time work (including volunteer)			
Watching TV / Using a computer (other than at work)			
Reading			
Relaxing			
Exercise/working out			
Time with children (homework)			
Time with children (sports) *Do not include activities already mentioned in Exercise/working out*			
Time with children (playing games)			
Other activity (specify)			
Other activity (specify)			
Other activity (specify)			

ANTHROPOMETRIC ASSESSMENT

Date: _____

Measurement	1	2	3	Average
Height (cm)				
				ft
Weight (kg)				
				lb
Waist circumference(cm)				
Hip circumference(cm)				

BMI: _____ Waist-Hip ratio: _____

HbA_{1c}: _____

APPENDIX I: Receipt collection protocol

28 DAY RECEIPT COLLECTION
for household food expenditure

FOR THE MAIN GROCERY SHOPPER IN THE HOUSEHOLD
Please collect and save all grocery, liquor store and restaurant receipts for 4 weeks (28 days).

Here is what we would like you to do:

- Place all grocery receipts, alcoholic beverage receipts and dining out receipts in the addressed envelope provided for each week.

- Keep envelope where easily found and convenient
  - This is where you will normally go when you arrive from grocery shopping or dining out
  - Place all receipts in the envelope *as soon as you can.*

- We will send a reminder to send in your receipts once/week

- When dining out and sharing a MEAL BILL with others
  - circle food and beverages YOU have paid for personally in ink.

- You may block out any information that is not related to food/beverage purchases.

- If no receipt is provided
  - record the name and location of the store, food(s) purchased, amount, cost of each item, and date in the notebook provided.
  - remove the page from the notebook and place it with the receipts in envelope for that week.

See reverse for examples

APPENDIX J: Food record

THREE-DAY DIETARY INTAKE RECORD

DAY 1 ONLY

Participant ID:_____

Phone Number: _____

Date of Birth: _____ _____ _____
(Day) (Month) (Year)

Record Dates: ____ _____ ____ _____ ____ _____
(Day) (Month) (Day) (Month)

University of Alberta
Department of Agricultural, Food and Nutritional Science

Instructions for Recording Daily Food Intake

The purpose of collecting this information is to know what you eat and drink during a three-day period. It is important to record ALL foods and beverages – whether it is a full course meal at home or a quick can of pop at school/work.

The Three-Day Dietary Intake Record has a separate section for every day (see Day 1, Day 2, Day 3 on top each page). Each day is broken up into 6 eating times:

1. Morning meal
2. Midmorning snack
3. Mi
4. Afternoon snack
5. Evening meal
6. Eve

It is a good idea to carry your Dietary Intake Record book with you and record your entries as soon after eating as possible. Foods and beverages consumed away from home – at a friend's house, at the mall, at a restaurant- are just as important as those eaten at home. Please include the following information on your food record:

FOOD AND BEVERAGE ITEMS Column: Enter all foods and beverages consumed at the meal or snack time. Please record the specific type of food (for example: *WHOLE WHEAT* bread, *FROSTED FLAKES* cereal). In the same column, record all toppings or items added at the time of eating (for example: sugar, syrup, jam, butter, mayonnaise, gravy, milk, salt, etc.). For combination foods, please include detailed information on each item. For example: If you had a tuna sandwich, you would list the following foods and include detailed information for each of them: white bread, mayonnaise, celery, solid white tuna, salt.

DESCRIPTION OF ITEM Column: For every food or beverage item listed, include the following (if applicable):

Brand: *MIRACLE WHIP* mayonnaise, *PIZZA HUT DEEP DISH* pizza, *OREO* cookie

Type of flavour: *BLUEBERRY* muffins, *STRAWBERRY* yogurt

Method of cooking: *FRIED, BAKED, BBQ'D, HOMEMADE*

All other relevant information included on food label: *LOW FAT*, ranch fat free salad dressing, *28% M.F. (MILK FAT*) cheddar cheese, *LEAN* Ground Beef ,

For fruits and vegetables specify the varieties if applicable e.g. "Granny smith" apple and other information's such as frozen, canned sweetened/unsweetened, sliced, peeled etc

AMOUNT Column**:** Specify number and units of measure of food or beverage item and the amount of any topping or items added. E.g. 2 cups, 1 Teaspoon. Use appropriate units of measures necessary e.g. "cup", "grams", "piece", "ounce", "number", size of fruit (small, medium, large), "teaspoon", or "tablespoon. Use measuring cups and spoons whenever possible.

Homemade foods - attach the recipe to the additional information sheet and mention the portion you had eaten E.g. $1/5^{th}$ of a batch of stew.

Restaurants: Include as much information as possible. Make sure you include the name of the restaurant, name of the dish and the options that you have chosen.

Please attach the food labels of processed foods if possible and do ensure that you have entered "label attached"

Fill in the blanks on the bottom of each record. Please list any vitamin or mineral supplements and/or herbal products taken, including quantities and detailed label information along with the Drug Identification number (DIN), if possible. Indicate the time of your meal or snack and where it was eaten (for example: at home, at a restaurant, in class). If you ate more than one snack between two meals, please indicate the time of each snack. If you did not eat a meal or snack, please place a check mark (✓) in the space provided on the bottom of the page, so that we do not think you forgot to record it.

Daily check: in the evening, after you have recorded everything for the day. Also check that the blanks are completed on the bottom of the page.

Dietary record should reflect the way you usually eat. Please do not change your normal eating habits for the 3 days you are recording your food intake. Your honesty is crucial to the success of this research study.

Thank you for your participation and cooperation with this study. **If you have any questions please contact: pandaresearch@med.ualberta.ca ; Phone number 780-248-1501**

Sample Meal

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon
Strawberry - Kiwi Juice	Sunrype 100% fruit juice	½ Cup (125 ml)
Bacon	Maple leaf regular	1 piece
Whole wheat bread:	Toasted, homemade (recipe attached)	2 Piece (small slice)
Margarine	Becel, polyunsaturated salt reduced spread	3 teaspoon
Peanut butter	Compliments, 100% natural crunchy	2 teaspoon (10 ml)
Jam	Blueberry haven, blueberry, no sugar	3 teaspoon
Granola bar	Nature valley, sweet and salty, gluten free, Almond (Label attached)	1 Bar
Apple	Granny smith	1 medium size

Vitamin/Mineral Supplements or Herbal Products taken: Ferrous sulphate 300mg Safeway 1 tablet DIN: 00346918

Fill in blanks: Time of meal/snack: 6:00 pm **Location meal/snack was consumed:** at home

Please CHECK (✓) if you did not eat or drink at this meal or snack time:

Day 1 - Morning Meal

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

Day 1 - Mid-Morning Snack

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

Day 1 – Midday Meal

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

Day 1 - Afternoon Snack

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units of units and measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

Day 1 - Evening Meal

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units of units and measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

Day 1 - Evening Snack

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

Vitamin/Mineral Supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack:_____ Location meal/snack was consumed:_____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:_____

ADDITIONAL INFORMATION

(For example: recipes or food/drink label information)

Sample Snack

Food and Beverage Items	DESCRIPTION OF ITEM	AMOUNT
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: Brand name Flavour Method of cooking All other relevant information on food/drink label	Enter number of units and units of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon

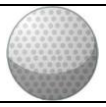
Vitamin/Mineral supplements or Herbal Products taken:_____
Fill in blanks: Time of meal/snack: _____Location meal/snack was consumed: _____
Please CHECK (✓) if you did not eat or drink at this meal or snack time:____

APPENDIX K: Serving size sheet

APRON SERVING SIZES FOR 24 HOUR FOOD RECALL

MILK PRODUCTS		
1 serving	**Equals**	**Equals**
1 oz/30g cheese	4 dice	
1 cup/250mL ice cream	baseball	
1 cup/250mL milk or other beverage	Fist	
½ cup/100 g yogurt ¾ cup/175 g yogurt	Purchased as multi-pack Purchased as individual	
GRAIN PRODUCTS		
1 serving	**Equals**	**Equals**
1 slice of bread	CD case	
½ -1 bagel	Hockey puck	
1 medium pancake	CD	

Vegetables and Fruit		
1 serving	**Equals**	**Equals**
½ cup/125 mL fresh, frozen, canned	Light bulb	
1 medium sized	Tennis ball	
1 cup/250 mL salad, raw, leafy	Softball	
2 Tbsp/30 mL dried fruit	Large egg	
1 small baked potato	Computer mouse	
1 cup/250mL juice	Fist	

MEAT AND ALTERNATIVES		
1 serving	**Equals**	**Equals**
3oz/90 g meat, chicken, cooked	Deck of cards	
3 oz/90 g fish, cooked	Cheque book	
½ cup/250 mL beans, lentils	Light bulb	
2 Tbsp/30 mL peanut butter	Golf ball	
2 Tbsp/30 mL nuts/seeds	1 oz shot glass	

FATS AND OILS		
1 serving	**Equals**	**Equals**
1 tsp/5 mL butter, margarine	1 dice or tip of your thumb	
2 Tbsp/30 mL dressing	Ping pong ball	

Adapted from Storey & Taylor Serving Sizes (2005) and Alberta Milk.

APPENDIX L: PANDA evaluation sheet
PANDA EVALUATION

You may fill this out and send with your LAST (4th week) receipt envelope or you may email your responses by indicating the question number followed by your response.

If using this form, please circle the appropriate response on a scale from 1-5, with:
1 being not difficult at all, 3 being neutral and 5 being extremely difficult

How **difficult** was it for you to follow and complete the following:

1. 28 day grocery and restaurant receipt collection

1 2 3 4 5

2. Three day food record

1 2 3 4 5

3. Activity recall

1 2 3 4 5

4. PANDA questionnaire and height/weight/blood collection

1 2 3 4 5

5. Do you have any suggestions that you feel will make these procedures easier and more efficient?

---

6. Do you have any additional comments?

---

7. Are you interested in participating in future PANDA projects?

Yes No

Your input is greatly appreciated!

APPENDIX M: Diabetes education questions

DIABETES EDUCATION QUESTIONS

1. When did you receive diabetes education last?

2. Was the topic of diet or nutrition covered in this diabetes education class?
   Yes No

3. Have you ever had an appointment with a dietitian? Yes No

   IF YES

   3. a. How often do you see them in a month?

   How often do you see them in a year?

   3. b. did this dietitian provide you with a diet plan to follow? Yes No
   3. c. Do you follow it?

   Not at all Rarely Sometimes Often Always

   If No

4. d. Why not (specify reasons)

5. Aside from dietitians or diabetes educators, where do you get information about nutrition (e.g. books, internet, family/ friends, physician etc)

APPENDIX N: Example of participant calendar

August 2009						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
July 26	July 27	July 28	July 29	July 30 Today	July 31 Start week 1 Grocery receipts	1
2	3	4	5	6	7 Send week 1 receipts	8
9 Food record Day 1	10 Food record Day 2	11 Food record Day 3	12	13	14 Send week 2 Receipts + Food record	15
16	17	18	19	20	21 Send week 3 receipts	22
23	24	25	26	27	28 Send week 4 receipts	29
30	31					

APPENDIX O: Participant identification sheet

PARTICIPANT ID	NAME	DATE
xpan 101-09		
xpan 102-09		
xpan 103-09		
xpan 104-09		
xpan 105-09		
xpan 106-09		
xpan 107-09		
xpan 108-09		
xpan 109-09		
xpan 110-09		
xpan 111-09		
xpan 112-09		
xpan 113-09		
xpan 114-09		
xpan 115-09		
xpan 116-09		
xpan 117-09		
xpan 118-09		
xpan 119-09		

APPENDIX P: Example of an activity recall

Participant: **XPAN 1xx-09 (participant)**
Recall date: August 18/09 Date recalled: August 17/09

Time	Code	Activity
9:00AM		Got up. Went for walk (20 minutes)
9:30		Made coffee. Drank 1 cup.
9:45		Prepared breakfast (cold cereal – 2 minutes to prepare and 5-10 minutes to eat). Ate breakfast by self
10:00		Errands. Drive and walk – made 7 stops (by self)
12:30PM		Returned home. Made lunch. Sandwich – 5-10 minutes to prepare. Ate lunch while watching news (1/2 hour).
1:30		Drove teen son to gym (5 minute drive). Did exercises with son: 40 minutes weights/machines – full body workout; 15 minute stair climber – easy and sprint. Showered before leaving for home.
3:15		Drive home. Prepared and ate snack. Shake, apple and nuts.
4:15		Worked on food record until 5:00
5:00		Drove to RONA (10 minute drive). Spent 20 minutes in store with family picking out house stuff. Afterward, drive to Red Robin for supper
6:00		Arrive at Red Robin. Appetizer is dry ribs. Dinner: 5 alarm burger, 3 diet cokes. Afterward, drive home (10 minutes)
7:30		Arrive home. Jumped on trampoline with 10 year old daughter for 20 minutes.
8:00		Went for 45 minute walk with wife. Visit neighbour for a few minutes during walk.
8:45		Arrived home. Recorded TV episode until 10:00
10:00		Put 10 year old to bed
10:30		Older kids (2) to bed.
11:00		Watched movie with wife until 1:00
1:00		Went to bed. Slept through night
9:00AM		Got up.

APPENDIX Q: Receipt entering and coding

VARIABLES
ID # - the participant ID given at the information session
Receipt # - the number given to each receipt in each envelope (receipt 1, 2, 3, 4, etc.)
ESTABLISHMENT type – the type of store (see below)
ESTABLISHMENT – the name of the store (Safeway, Walmart, etc)
Week# - the receipts were collected for four weeks. This represents whether it was the first, second, third or fourth week
Date – the date of the purchase
Commodity (category) – food category (see below)
Product – the commodity was broken down further. For example, nuts were broken down into walnuts, peanuts, etc.
Brand – there were four categories; generic, store brand, popular brand and quality brand.
Size (grams) - since products are sold by either volume (mL), weight (g) or count (1,2,3), I have included all three and recorded what was applicable (if stated)
Size mL – since products are sold by either volume (mL), weight (g) or count (1,2,3), I have included all three and recorded what was applicable (if stated)
# of items - since products are sold by either volume (mL), weight (g) or count (1,2,3), I have included all three and recorded what was applicable (if stated)
Total – total cost of the item at this point
card savings/staff discounts, coupons, etc – cost of the item after card savings (Safeway, Save-on, etc)
GST – GST was added on to each applicable item (Total - card savings)*.05. Items with GST added are generally restaurant items and in-store prepared items. If in doubt, the total GST was compared with the GST added from each applicable item on the receipt. They should be equal.
TOTAL – total at this point (GST + (Total – card savings))
Specials (eg 15% off Tuesday) – store specials, such as 15% off everything in store was calculated for each item
Tip (if stated)
Real Total

Establishment type

1chain store (supermarket)
2specialty (Planet organic, etc)
3convenience stores
4liquor stores
5restaurant (fast food/coffee)
6restaurant (intermediate)
7restaurant (dining)
8 drug store
9 vending machine/venders
10catering
11Warehouses
12Golf courses
13not stated (restaurant)
14gas station
15theatre
16stadium,gaming, computer cafes

Category of food

1fruit/veg
2fruit/veg juice
3bread
4cereals
5milk
6other dairy
7nuts
8 red meat
9fish and seafood (not ready to eat)
10poultry
11eggs
12 baking/cooking ingredients
14bakery products
16soups (dried/cold)
18condiments (ketchup, mustard, BBQ sauce, etc)
20sauces (gravy, spaghetti sauce, salad dressings etc)
24rice/qunioa
25pasta
30meal prep required (taco shells, hamburger helper, sidekicks, Kraft Dinner, egg noodles)
35fixins (dumplings, etc)
37veggie (fake) meats
40ready to eat meals/dishes from store/frozen entrees
45canned fish, ready-to-eat fish
46canned meat (Klik, corned beef, etc)
47canned soup
50snack foods
60desserts
65coffee, tea (store)
66soft drinks (store)
67alcoholic drinks
70spreads
75 meal replacements
79store food - cannot identify
80 restuarants fast food
120 restaurants intermediate
160 restaurants fine
180catering
200not stated
300other misc

Product

1peanuts
2cashews/pecans
3almonds
4pinenuts/macademia
5soya mix
6pistachios
7sunflower seeds, flax seeds, pumpkin seeds, etc
8'crunchy' nuts(pc)
9'deluxe' nuts, Olympic mix, Trail mix
10walnuts/chestnuts

10's = fruit and veg

11 = fresh fruit
12 = fresh veg (incl potato)
13frozen fruit
14frozen veg
15canned fruit/fruit cocktail
16canned veg/pickles
17dried fruit
18dried veg, legumes
19special (grapple)

21-30juices

20coconut milk
21orange
22apple
23juice mixed
24tomato juice
24pomagranite
25concentrated orange
26conc. Apple
27tomato cocktail
28juice not stated
29cranberry/grape
30 pulp

30's breads

31loaf (white, whole wheat)
32bagel
33baguette, panini, pagnotta
34buns (incl hot dog, burger), dinner; rolls, bread crumbs
35waffles