Assessment of the effectiveness of the Physical Activity and Nutrition for Diabetes in Alberta (PANDA) nutrition intervention for type 2 diabetes patients

by

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Abstract

Type 2 diabetes patients often find integrating a new dietary pattern into their lifestyle challenging; therefore, the PANDA (Physical Activity and Nutrition for Diabetes in Alberta) nutrition intervention was developed to help people incorporate the Canadian Diabetes Association (CDA) nutrition therapy guidelines into their daily lives. The overall objective of this thesis was to evaluate the effectiveness of the PANDA nutrition intervention on glycated hemoglobin (A1c) and dietary adherence to guidelines.

We conducted a single-arm trial in 73 participants with type 2 diabetes that measured outcomes at baseline, three and six months and allowed us to address the following aims: (1) To measure the reliability of the Perceived Dietary Adherence Questionnaire (PDAQ) and its validity relative to three repeated 24-h dietary recalls; (2) To evaluate the effectiveness of the intervention (menu plan plus education sessions) to improve glycemic control and diet quality and adherence; and (3) To identify the main food sources of sodium, saturated fat and added sugars and the influence of the PANDA intervention on food choices affecting intake of those nutrients. The intervention curriculum was based on Social Cognitive Theory and included 5 weekly group sessions, a grocery store tour, a four-week menu plan that incorporated the overall recommendations of the CDA nutrition therapy guidelines and hands-on activities.

To measure validity of the PDAQ, individual sub-scores were correlated with specific information derived from the three 24-h dietary recalls (i.e., mean servings of food groups, nutrient intakes, glycemic index) using data from 64 trial participants for whom complete dietary data were available. The correlation coefficients for PDAQ items versus 24-h recalls ranged from 0.11 to 0.46. The correlation coefficient for the entire questionnaire was acceptable ($r = 0.76$). Reliability was determined using a test-retest protocol in 20 type 2 diabetes

participants recruited for this purpose. The intra-class correlation (0.78) was acceptable, indicating good reliability.

Three months after initiating the PANDA nutrition intervention in 73 participants, assessments were conducted in 64 program completers (88%). There were statistically significant reductions in A1c (-0.7% (95% CI ,-1.0, -0.4)), body mass index (BMI, -0.6 kg/m^2 (95% CI,-0.8, -0.4)), systolic blood pressure (-4 mm Hg (95% CI,-6.8, -1.3)), total cholesterol (TC, -63 mg/dL (95% CI, -80.1, -46.9)), high density lipoprotein (HDL)- (+28 mg/dL (95% CI, 20.2, 34.8)) and low density lipoprotein (LDL)-cholesterol (-89 mg/dL (95% CI, -105.3, -72.5)). Significant improvements were maintained at 6 months in A1c, BMI, total-C, LDL-C and HDL-C. At 3 months, significant increases were observed in Healthy Eating Index (HEI, +2.1 score (95% CI, 0.2, 4.1)) and PDAQ (+8.5 score (95% CI, 6.1, 10.8)). After controlling for baseline A1c, BMI, age, and gender, a change in HDL-C of 10 mg/dL predicted -0.22% (95% CI, -0.041, -0.001) change in A1c, whereas -1 kg/m^2 in BMI predicted -0.114% (95% CI, -0.33, -0.019) change in A1c.

Because saturated fat, added sugar and sodium intakes were significantly decreased, and because there are specific recommendations for reducing intake of these nutrients, the main food sources of these nutrients was determined pre- and post-intervention. After 3 months, there was a reduction in sodium intake of 561 (95% CI (-891, -230)) mg/day, mainly due to reduced consumption of processed foods including meats and soups. Significantly lower intake of fat-containing milk and processed meat contributed to -2.9 (95% CI (-6.1, -0.1)) g/day saturated fat intake while added sugar intake declined by 7.0 (95% CI (-13.9, 1.8)) g/day, due to lower consumption of baked desserts/pastries and chocolate.

The results suggest that PDAQ is a valid and reliable measure of adherence to Canadian diabetes nutrition recommendations in individuals with type 2 diabetes. The PANDA menu plan intervention was effective in improving glycemic control, anthropometric measures and dietary adherence in the short term. Changes in dietary intake of specific foods resulted in lower intakes of saturated fat, sodium and added sugar. These results suggest that a dietary intervention incorporating education sessions focused on menu planning and hands-on activities may be effective for diabetes management and behavioral changes, thereby providing support for a larger trial.

Preface

All of the work presented in this dissertation was conducted at the University of Alberta. The research project named “Diet adherence and acceptability questionnaires for diabetes: reliability testing” (Pro0053310) was approved by the Human Research Ethics Board at the University of Alberta and covered part of the research described in Chapter 2. The research project named “Physical Activity and Nutrition for Diabetes in Alberta (PANDA): Effectiveness Testing” (Pro0031490) was approved by the Human Research Ethics Board at the University of Alberta and covered the remainder of the research described in this thesis.

The research presented in Chapter 2 was published by *Nutrients* in 2015. The citation is: Ghada Asaad, Maryam Sadegian, Rita Lau, Yunke Xu, Diana C. Soria-Contreras, Rhonda C. Bell and Catherine B. Chan. The reliability and validity of the perceived dietary adherence questionnaire for people with type 2 diabetes. Nutrients 2015, 7, 5484-5496; doi: 10.3390/nu7075231. Chapter 3 is submitted to the journal Diabetes Care, the title of which is Effectiveness of a Lifestyle Intervention in Patients with Type 2 Diabetes: The Physical Activity and Nutrition for Diabetes in Alberta (PANDA) Trial with authors Ghada Asaad, Diana C. Soria-Contreras, Rhonda C. Bell and Catherine B. Chan. Chapter 4 will be submitted to the British Journal of Nutrition, with the title Food Sources of Sodium, Saturated Fat and Added Sugar in the Physical Activity and Nutrition for Diabetes in Alberta (PANDA) Trial and authors Ghada Asaad and Catherine Chan, after publishing chapter 3.

The other authors have given their permission for the work to appear in this thesis.

Contributions are delineated as follows:

Dr. Catherine B. Chan designed and wrote the grant that funded the study. Dr. Catherine B. Chan and Dr. Rhonda C. Bell designed the PDAQ, the menu plan and the intervention trial. Diana C. Soria-Contreras and I carried out the participant recruitment and data collection for the main trial, while Maryam Sadegian, Rita Lau, Yunke Xu and I performed these functions for the test-retest reliability trial. Diana C. Soria-Contreras conducted the intervention sessions of the PANDA intervention. I entered and analyzed the data, with assistance from Maryam Sadegian, Rita Lau, Yunke Xu for the test-retest reliability trial. I wrote the manuscripts. Where named as authors, Dr. Catherine B. Chan and Dr. Rhonda C. Bell provided critical feedback and edits on data analysis, data interpretation, and manuscript presentation. All authors reviewed the manuscripts, provided editing and feedback and approval of its submission.

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List of abbreviations

24-h recall	24-hour recall
A1c	Glycated hemoglobin A1C
AHEAD	Action for Health in Diabetes
BMI	Body Mass Index
BP	Blood pressure
CCHS	Canadian Community Health Survey – Nutrition
CDA	Canadian Diabetes Association
CFG	(Eating Well with) Canada's Food Guide
CRP	C-reactive protein
CVD	Cardiovascular disease
DRI	Dietary Reference Intake(s)
DSES	Diabetes Self-Efficacy Scale
FFA	Free fatty acid
FFQ	Food Frequency Questionnaire
FPG	Fasting plasma glucose
FSP	First Step Program
GI	Glycemic index
GL	Glycemic load
HDL-C	High-density lipoprotein cholesterol
HEI	Healthy Eating Index
IDF	International Diabetes Federation
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
IL-6	Interleukin 6
LDL-C	Low-density lipoprotein cholesterol
MetS	Metabolic syndrome
MUFA	Monounsaturated fatty acid(s)
NHANES	National Health and Nutrition Examination Survey
OGTT	Oral glucose tolerance test
PAI-1	Plasminogen activator inhibitor-1
PANDA	Physical Activity and Nutrition for Diabetes in Alberta
PDAQ	Perceived Dietary Adherence Questionnaire
PUFA	Polyunsaturated fatty acid(s)
RCT	Randomized clinical trial(s)
SCT	Social Cognitive Theory
SFA	Saturated fatty acid(s)
SHS	Strong Heart Study
T2D	Type 2 diabetes
TC	Total Cholesterol
TG	Triglycerides
TNF-α	Tumour necrosis factor-alpha
UKPDS	United Kingdom Prospective Diabetes Study
WHO	World Health Organization

Chapter 1. Introduction and literature review

1.1 Introduction

Type 2 diabetes (T2D) is a chronic disease characterized by high blood glucose levels (hyperglycemia) due to defects of insulin secretion, insulin action or both (Dworatzek et al., 2013). Diabetes has reached the level of an epidemic and is found in almost every population worldwide. Today more than 415 million people live with diabetes, and by 2040, the number of cases is predicted to reach roughly 642 million people (International Diabetes Federation (IDF) 7th edition, 2015). In Canada, more than 3 million Canadian adults have been diagnosed with T2D. Researchers predict that the number of cases will rise to 3.7 million by the year 2019 (Cheng, 2013). Although Canada is not one of the top ten countries in terms of incidence of diabetes, it ranks in the top seven nations in terms of diabetes spending (IDF, 2015). The growing diabetes epidemic has had a devastating impact on quality of life and overall health-care costs. Diabetes is a leading cause of heart disease and stroke, high blood pressure, blindness, kidney disease, nervous system disease (neuropathy), and amputation (Cheng, 2013). The consequences of diabetes are significant; therefore, there is urgency to slow the development and progression of the disease to save health care expenditures and to increase patient quality of life. The United Kingdom Prospective Diabetes Study (UKPDS) investigated the effect of intensive blood glucose control versus conventional treatment in patients with T2D over approximately 10 years. Researchers demonstrated a direct relationship between the risk of diabetic complications and increasing levels of glucose in the bloodstream (glycemia) over time. The study found that for each 1% absolute reduction in mean glycated hemoglobin A1c (A1c) levels there was an associated 37% decrease in the risk of microvascular complications and a 21% reduction in the risk of any diabetes-related complication or death (Stratton et al., 2000).

One way to approach treatment of the disease is through implementation of lifestyle interventions that are both cost effective and beneficial for T2D patients.

Diet plays an essential role in the control of blood glucose levels in persons with diabetes. The Canadian Diabetes Association (CDA) nutrition therapy recommendations state that people with diabetes should consume a variety of foods from the four groups (fruits and vegetables, grain products, milk and alternatives, and meat and alternatives) according to Canada's Food Guide (CFG). Additional recommendations include limiting saturated fat and restricting added sucrose and fructose to 10% of total energy while increasing the consumption of low glycemic index foods, high-fiber foods, monounsaturated fats and foods rich in n-3 fatty acids (Dworatzek et al., 2013). However, diabetic patients find difficulty in translating nutrition recommendations into practice. Factors related to food environment factors, including elements of food availability/accessibility/acceptability, affect adherence to a healthy diet in the general population (Riely, 1999), but its impact on dietary adherence in diabetes is less-well understood. Therefore, the Physical Activity and Nutrition for Diabetes in Alberta (PANDA) team designed a four-week menu plan that translates the recommendations of the CDA, thus meeting the food group serving recommendations as suggested in CFG and additional diabetes-specific recommendations. The menu was designed to take into account environmental factors, including food availability, accessibility, acceptability, and adequacy. Despite the well-documented health benefits of nutrition intervention for T2D, to our knowledge none of the previous interventions have been introduced to address the issue of environmental barriers to dietary adherence.

In the clinical setting, dietitians need appropriate assessment tools to determine the level of adherence to nutrition recommendations. However, the majority of assessment tools used require skill to analyze and can be time consuming. In order to develop an appropriate questionnaire to fill this gap, a valid procedure should be identified.

The purpose of this literature review is to provide background and rationale for the major objectives of this thesis work, which are to (1) measure the reliability of Perceived Dietary Adherence Questionnaire (PDAQ) and its validity relative to three repeated 24-h dietary recalls among T2D patients and (2) evaluate the effectiveness of an intervention that includes a menu plan plus education sessions among people with T2D in improving glycemic control and diet quality. Therefore, the review topics include T2D and nutrition therapy for people with diabetes. The facilitators and barriers, including environmental barriers, to achieving good nutrition are discussed. The utility of current dietary assessment methods for measuring dietary adherence is compared in this context. Finally, the literature regarding published nutrition interventions for people with diabetes, their main outcomes, strengths and weaknesses are discussed. The latter includes related work from the PANDA study conducted by our research group, into which methods of addressing the food environment are incorporated.

1.2. Literature Review

1.2.1 Diabetes definitions and diagnosis

Diabetes is a metabolic disease that is diagnosed on the basis of sustained high concentration of glucose in the blood. According to CDA guidelines, T2D is defined as "a metabolic disorder characterized by the presence of hyperglycemia due to defective insulin secretion, defective insulin action or both" (Goldenberg & Punthakee, 2013). T2D is the most common type; of those diagnosed with diabetes, 90%-95% have T2D. According to the CDA guidelines the current diagnostic criteria for diabetes are: 1) Fasting plasma glucose (FPG) concentration measured after an overnight fast above 7.0 mmol/L; 2) oral glucose tolerance test (OGTT) - plasma glucose concentration measured two hours after a 75g oral glucose load above 11.0 mmol/L; 3) A1c test (the average of blood sugar over the past three months) above 6.5%.

1.2.2 Type 2 diabetes pathogenesis

T2D is a metabolic disorder characterized by insulin resistance and/or abnormal insulin secretion (impaired β-cell function) (Franz & Evert, 2012). Elevated levels of inflammatory cytokines secreted from enlarged fat cells in those with excess weight can increase the risk of T2D (Franz & Evert, 2012). Insulin resistance increases and beta cell loss during pre-diabetes years lead to the progression of the diabetes (Franz & Evert, 2012). T2D has been associated with a number of risk factors, including metabolic risk factors, genetics, and lifestyle factors.

1.2.2.1 Metabolic risk factors

A number of metabolic disorders consistently associate with the development of T2D and are considered to be risk factors including: obesity, dyslipidemia, elevated blood pressure, dysglycemia, and metabolic syndrome (Fletcher, Gulanick, & Lamendola, 2002). Obesity has been linked with hyperinsulinemia and insulin resistance, which are both recognized at the pre-diabetes stage (Weyer et al., 2001). Abdominal obesity is a well-documented risk factor for T2D, and in European individuals is defined as a waist circumference of greater than 88 cm for females, and greater than 102 cm for males (Booth & Cheng, 2013). Adipose tissue is known to produce cytokines that have been linked with T2D (Weyer et al., 2001). Cytokines such as tumour necrosis factor-alpha (TNF-α), plasminogen activator inhibitor-1 (PAI-1), and interleukin-6 (IL-6) have direct negative effects on the insulin signaling pathway. C-reactive protein (CRP) is an acute-phase reactant plasma protein and a marker of inflammation. An analysis of National Health and Nutrition Examination Survey (NHANES) data found that both newly- and previously-diagnosed T2D had elevated CRP independent of BMI (Ford, 1999). The link between CRP and obesity in the development of T2D is described by Hotamisligil et al. (1995). Adipocytes in obese individuals tend to overproduce TNF-α. TNF-α induces production of IL-6 in various cell types, which leads to increased CRP plasma concentration.

Dyslipidemia is consistently linked with T2D, and is documented as a risk factor for its development. Plasma free fatty acid (FFA) levels are generally higher in obese individuals and elevated levels have been shown to inhibit insulin-dependent peripheral glucose uptake in a dose-dependent manner in patients with and without T2D (Boden, 1997). High levels of serum triglycerides (TG) (hypertriglyceridemia) is also a common disorder in the etiologic pathway of T2D (McGarry, 2002).

Elevated blood pressure, or hypertension, is a long-established risk factor for T2D. The Women's Health study has shown that elevated blood pressure (BP) is an independent predictor of incident T2D, and obese women are at greatest risk for T2D compared to lean women (Conen, Ridker, Mora, Buring, & Glynn, 2007). A study by Izzo et al. (2009) also has shown that uncontrolled blood pressure is associated with twofold increased risk of incident diabetes.

Dysglycemia is impaired glucose metabolism and hyperglycemia in the pre-diabetic state. Pre-diabetes is a strong independent predictor of T2D. Around 5–10% of people with pre-diabetes become diabetic every year (Tabak, Herder, Rathmann, Brunner, & Kivimaki, 2012). Impaired fasting glucose (IFG) is defined as FPG concentration of $\geq 6\cdot 1$ and $<7\cdot 0$ mmol/L. Impaired glucose tolerance (IGT) is defined as a 2 h post-load plasma glucose concentration of $\geq 7\cdot 8$ and $<11\cdot 1$ mmol/L, measured during a 75 g OGTT (Tabak et al., 2012). Both IGT and IFG are predictors of T2D risk; however, IGT has proven to be even more predictive than IFG (Shaw et al., 1999).

Metabolic syndrome (MetS) is a clustering of well-documented risk factors for T2D as well as serious disease. The worldwide prevalence of metabolic syndrome is increasing. The prevalence ranges from 6.8% in the South Korea NHANES (KNHANES) cohort to 34.2% in the USA NHANES CVD cohort (Shin et al., 2013). Many diagnostic criteria for the MetS have been proposed but in 2009, a harmonized criteria for MetS was established. A MetS diagnosis is characterized by at least three criteria or more of the following: abdominal obesity for Canada, United States (waist circumference > 88 cm for females, >102 cm for males), hypertriglyceridemia (TG ≥ 1.70 mmol/L), low HDL-C (< 1.3 mmol/L in females, < 1.0 mmol/L in males), elevated BP (≥ 130/85 mmHg), and high fasting glucose (≥ 5.6 mmol/L) (Alberti et al., 2009).

1.2.2.2 Genetic risk factors

Genetic factors are believed to play an important role in development of T2D. Individuals with a first-degree relative with T2D are at an increased risk of developing T2D (Booth & Cheng, 2013). A systematic review and meta-analysis has shown that specific population groups such as African and East Asian are at greater risk of developing T2D and this may be attributable to genetics (Kodama et al., 2013). In a review by Ali (2013), various genetic loci that contribute to the heritability of T2D were identified. Ten loci were associated with reduced beta-cell function and only three loci were associated with reduced insulin sensitivity.

1.2.2.3 Lifestyle risk factors

An unhealthy "westernized" diet that features large amounts of red and processed meats, fats, and sugar has been linked with a 60% increase in diabetes prevalence (van Dam et., 2002). Recently, specific food components and nutrients have been investigated for their role in T2D development. Epidemiological studies found an association between higher fasting insulin and glucose levels and high saturated fat diet. Findings from clinical trials support a diet that is rich in whole grains, fruits and vegetables, and other high fiber carbohydrates to reduce risk of diabetes. Overall a diet that is low in total fat (<30% of energy), especially animal fat and saturated fat, and simple sugars appear to be best in prevention of diabetes (J. Salas-Salvadó, Martinez-González, Bulló, & Ros, 2011). The Mediterranean-style diet without calorie restriction was inversely associated with diabetes incidence (Jordi Salas-Salvadó et al., 2011). Meta-analysis of prospective cohort studies showed that individuals who consumed a lower-glycemic load diet were at significantly lower T2D risk (Livesey, Taylor, Livesey, & Liu, 2013).

The Nurses' Health Study and the Physicians' Health Study have shown evidence of protective effects of exercise against the development of T2D (Manson et al., 1991, 1992). Other research has shown that a lack of exercise may increase risk of T2D (Durstine, Gordon, Wang, & Luo, 2013). Exercise has been associated with improved insulin sensitivity, weight maintenance and weight loss (Booth & Cheng, 2013).

1.2.3 Significance of diabetes problem

The number of people expected to be diabetic by 2030 is expected to be roughly 500 million (IDF, 2015). The effects of diabetes include pathophysiological changes, which have their own complications as well as their impacts on overall quality of life. Uncontrolled diabetes is associated with long-term complications. The UKPDS investigated the effect of blood glucose in patients with T2D over 10 years. Each 1% reduction in (A1C) levels was associated with a 37% decrease in the risk of microvascular complications and a 21% reduction in the risk of any diabetes-related complication or death (Stratton et al., 2000). Individuals with diabetes are at higher risk of heart disease and stroke, high blood pressure, blindness, kidney disease, nervous system disease (neuropathy), and amputation (Booth & Cheng, 2013). T2D has a negative impact on lifespan and quality of life. Unfortunately, evidence shows that one in 20 deaths are from complications related to diabetes; worldwide 8,700 people die every day, which averages to about six every minute (WHO, 2011). A recent systematic review of the global evidence on the costs of type 2 diabetes conducted by Seuring, Archangelidi & Suhrcke (2015) identified 86 cost-of-illness per capital and 23 labour market studies in high-income and low- and middle-income countries. The direct annual costs of diabetes ranged from $242 in Mexico to $11,917 in the USA, whereas the indirect costs ranged from $45 in Pakistan to $16,914 in the Bahamas. Besides measuring the cost of diabetes, some studies measured the impact of diabetes on productivity including employment probabilities and lost work-days and income or earnings. The impact of diabetes on employment chances for males ranged from no effect in Canada to a 19 % point reduction in Taiwan, while for women the range was from no effect in Canada, Taiwan, Australia or for Mexican Americans to a 45 % decrease in employment chances reported in the USA. For lost earnings, no effect was found for Mexican-American men in Texas, meanwhile, the highest loss was found for women in the USA ($21,392 per year). In Canada, earnings were reduced by 72% when complications were revealed to the employer (Seuring, Archangelidi, & Suhrcke, 2015).

1.2.4 Diabetes and quality of life

Dealing with diabetes issues continually throughout the day can negatively affect the perceptions of quality of life for individuals with T2D. Healthy People 2020 identified increased quality of life for diabetic patients as a national health care priority, along with reducing the economic burden of diabetes (United States Department of Health and Human Services [DHHS], 2013). A review conducted by Wändell (2005) identified health-related quality of life issues among diabetes patients in the Nordic countries. Most of the studies showed that quality of life for people with diabetes was worse than the non-diabetic group. Quality of life affected diabetic patients primarily through macrovascular complications, especially coronary heart disease. Also, some studies reported a negative association between glycemic control and quality of life, and well as some psychosocial factors including health-related beliefs, social support, and coping style (Rubin, 2000).

1.2.5 Diabetes nutrition treatment goals

According to the CDA the goals of nutrition therapy are "to maintain or improve quality of life and nutritional and physiological health; and to prevent and treat acute and long-term complications of diabetes, associated comorbid conditions and concomitant disorders" (Dworatzek et al., 2013). Nutrition therapy can reduce A1c by 1.0% to 2.0%, improve serum cholesterol levels, and facilitate weight management. There are many dietary approaches to the management of T2D includes low-carbohydrate, low-glycemic index, high protein, and Mediterranean diets. A recent systematic review and meta-analysis assessed the effect of various diets on glycemic control, lipids, and weight loss in patients with T2D. A total of 20 randomized clinical trials (RCT) showed that following low-carbohydrate, low-glycemic index, high protein, or the Mediterranean diet improved glycemic control. Weight loss was greater after following low-carbohydrate and Mediterranean diets. Increases in HDL were documented in all diets except high protein diet (Ajala, English, & Pinkney, 2013). Nutrition recommendations for diabetic patients are summarized below along with important studies from the literature.

1.2.5.1 Carbohydrate recommendations

Carbohydrates consist of sugars, starches and fiber. Carbohydrate composition recommendations for patients with T2D vary between 45-60% of total energy per day. The Dietary Reference Intakes (DRI) recommended a minimum of 130g/d of carbohydrate because that is utilized by the brain (USDA, 2002). For a 2000 kcal/day diet, carbohydrate intake should range from 225-300 g. Restricting the intake of carbohydrates from 45% to 4% of total energy per day (ie. in a very low-carbohydrate diet) can improve A1c and triglyceride levels, but does not improve Total Cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), or Low-Density Lipoprotein Cholesterol (LDL-C). A meta-analysis provides evidence on the effectiveness of carbohydrate-restricted diets (9%-45% of total energy from carbohydrate) in patients with T2D. Eleven American and Canadian studies were included in the analysis. In 9 out of 11 studies, A1c decreased, ranging from -2.2 to -0.2%. A very strong relationship was observed between reductions in triglyceride levels and lower-carbohydrate diet, meanwhile, no associations were found between TC, HDL-C, or LDL-C and lower-carbohydrate diet (Kirk et al., 2008). Although low-carbohydrate diets improved A1c and triglycerides, the CDA recommends a carbohydrate intake not less than 45% of total energy per day to prevent high intakes of fat, and sufficient vitamin, mineral and fibre intake (Dworatzek et al., 2013). The long-term sustainability and safety of low carbohydrate diets is not clear.

1.2.5.1.1 Glycemic index recommendation

The glycemic index (GI) measures how an item of food (containing carbohydrates) raises blood glucose. The CDA suggests that diabetic patients use the GI as a guide in selecting foods for meal planning (Dworatzek et al., 2013). Low- and medium-GI foods have been shown to produce clinically significant improvements in glycemic control and cardiovascular risk factors. A meta-analysis of the effect of low GI in management diabetes summarized evidence of 14 randomized cross-over or parallel experimental design of 12 days to 12 months duration. The authors compared low GI with high GI diets. An improvement in glycemic control (-0.4%) was afforded by the low-GI diets (Brand-Miller, Hayne, Petocz, & Colagiuri, 2003). A review conduced by Kristo, Matthan, & Lichtenstein (2013) summarized the effect of diets differing in GI/glycemic load (GL) on cardiovascular disease (CVD) risk factors. Five randomized controlled-feeding trials examined the effect of low and high GI/GL diet with a minimum of four weeks duration, and reported at least one outcome related to CVD risk. Inconsistent effects of the GI/GL value of the diet on CVD risk factors were reported in this study. An unexpected increase of fasting glucose was observed in the low GI/GL phase compared to the high GI/GL phase. TC, LDL-C and HDL-C concentrations were higher in the low GI/GL phase in one study, and the low GI/GL diet did not appear to have a significant effect on plasma lipid in three studies.

1.2.5.1.2 Fiber recommendation

The CDA 2013 Nutrition Therapy guidelines suggest that increasing dietary fiber in the diet of patients with T2D is beneficial for improving postprandial blood glucose control because it slows down gastric emptying and delays the absorption of glucose into the small intestine. The CDA recommends that adults with diabetes consume 25 to 50 g/day of fiber (Dworatzek et al., 2013). A systematic review with meta-analysis of 11 randomized controlled trials that assessed the effect of fiber intake on glycemic control in patients with T2D was published recently. The duration of the studies ranged from 8−24 weeks. High-fiber diets (up to 42.5 g/day; four studies) or supplements containing soluble fiber (up to 15.0 g/day; nine studies) improved glycemic control by 0.5% (95% CI −0.96 to −0.13) (Silva et al., 2013). The Academy of Nutrition and Dietetics reported that 44-50 g of daily fiber intake has shown benefits on glycemic control while intake up to 24g of fiber did not improve glycemic control (The Academy of Nutrition and Dietetics, 2008). During a 26-year follow-up of 7,822 females with T2D in the Nurses' Health Study, intake of whole grains, cereal fiber and bran were negatively associated with all cause and CVD mortality (He, van Dam, Rimm, Hu, & Qi, 2010).

1.2.5.1.3 Added sugar recommendation

Sucrose intake up to 10% of total daily energy does not have an effect on glycemic control or the lipid profile of an individual with T2D. The CDA (Dworatzek et al., 2013) and the

World Health Organization (WHO, 2014) suggest that added sugar intake should be less than 10% of total calories; meanwhile, the American Diabetes Association (Franz & Evert, 2012) recommend less than 25% of total calories from added sugar. The Academy of Nutrition and Dietetics stated that sucrose intakes of 10-35% of total energy intake do not affect glycemic or lipid responses (AND, 2008). Another study showed that sucrose intake of 16% of total daily energy may increase blood glucose and triglycerides (Coulston et al., 1985), or intake more than 120 g per day may increase blood glucose and triglycerides (Jellish, Emanuele, & Abraira, 1984).

1.2.5.2 Protein recommendations

There is insufficient evidence to suggest that the usual daily intake of protein (15-20% of total energy for the general population) needs to be modified for diabetic patients who are otherwise healthy. However, the recommended daily allowance for protein for diabetic patients with chronic kidney disease is 0.8g/kg (Dworatzek et al., 2013). A review conducted by Hamdy & Horton (2011) discussed the effects of different amounts of protein intake in a diabetes meal plan. Protein intake of 1.5 to 2 g/kg (or 20–30% of total caloric intake) did not increase plasma glucose, but increased the insulin response resulting in a reduction in A1c. High protein intake also has been shown to be an effective tool for weight management in patients with diabetes. Dietary pulses (e.g. beans, peas, chickpeas, lentils) are considered as a meat alternative in CFG (Health Canada). The CDA nutrition guideline recommended specific foods such as dietary pulses (e.g. beans, peas, chickpeas, lentils). A systematic review and meta-analysis of 41 randomized controlled trials in people with and without diabetes found that pulses alone (11 trials) lowered fasting blood glucose (-0.82, 95% CI -1.36 to -0.27) and insulin (-0.49 95% CI -0.93 to -0.04). Pulses in low-GI diets (19 trials) lowered A1c (-0.28 %, 95% CI -0.42 to -0.14), and in high-fibre diets (11 trials) lowered fasting blood glucose (-0.32 95% CI -0.49 to -0.15) and A1c (-0.27 %, 95% CI -0.45 to -0.09) (Sievenpiper et al., 2009). A systematic review conducted by Pasin & Comerford (2015) examined the existing evidence from clinical trials investigating the effects of dairy foods and dairy proteins on the glycemic and insulinemic response of subjects with T2D. Both dairy foods (milk, cheese, and yogurt) and dairy proteins (casein and whey protein) have shown promise for improving insulin secretion in individuals with T2D. However, current recommendations make no specific recommendations regarding dairy protein.

1.2.5.3 Fat recommendations

The CDA recommends that people with type 2 diabetes consume fat in the range of 20-35% of energy intake, similar to the general population. Studies have shown the beneficial effects of monounsaturated (MUFA) (recommended at 20% of total energy) and polyunsaturated fatty acids (PUFA) such as plant oils and long-chain omega-3 fatty acids (10% of total energy) over saturated fatty acids (SFA) (less than 7% of total energy) and trans fatty acids. A systematic review and meta-analysis sought to find evidence that increasing the intake of PUFA as a replacement for SFA could reduce the rate of cardiac-related deaths in the population. The meta-analysis of the 9 RCTs showed that increasing PUFA consumption as a replacement for SFA reduced the risk of coronary heart disease events by 19%. For each 5% increase in total energy from PUFA, coronary heart disease risk was reduced by 10% (Mozaffarian, Micha, & Wallace, 2010). A Cochrane review and meta-analysis investigated the effect of replacing animal fats with plant oils, unsaturated spreads and more starchy foods. Replacing SFA with PUFA fats reduced the risk of heart and vascular problems. There was no clear effect of replacement SFA with MUFA, likely because there was only one small study. The review also did not find a clear evidence of the benefits of replacing SFA with starchy foods or protein (Hooper, Martin, & Abdelhamid, 2015). A meta-analysis of interventions that examined the effect of replacement of SFA with omega 6 linoleic acid on all-cause and CVD mortality found that rates of death from CVD, coronary heart disease, and all cause mortality decreased compared with a control diet rich in SFA (Ramsden et al., 2013).

A review was conducted to investigate the possible roles of omega-3 fatty acids in reducing CVD risk in patients with diabetes. Long-chain omega-3 fatty acids were not shown to improve glycemic control, but did improve lipid profile, decreased inflammation, and lowered blood pressure (McEwen, Morel-Kopp, Tofler, & Ward, 2010).

1.2.5.4 Sodium recommendation

There is no specific recommendation for sodium intake according to the CDA. Health Canada reported that the average of sodium intake of adult Canadians is 3400 mg. Health Canada recommends that people aged 14 and over should not exceed the Tolerable Upper Intake Level (UL), which is 2300 mg/d. The Dietary Approaches to Stop Hypertension study has shown that a moderate sodium intake (2400 mg) decreases systolic and diastolic blood pressure, decreases A1C, and has beneficial effects on cardio metabolic risk (Azadbakht et al., 2011). The American dietary guidelines recommend daily sodium intake of less than 1500 mg to adults who are 51 and older, African-Americans, or those who have hypertension, diabetes, or chronic kidney disease (USDA, 2010). An estimation conducted by Joffres et al. (2007) showed that a reduction by 1840 mg/day in sodium intake would prevent 235,000 individual/ year from taking required medication for hypertension in Canada (Joffres, Campbell, Manns, & Tu, 2007).

1.2.6 Dietary assessment

To assess nutrition intake compared with dietary guidelines, dietary assessment methods are used to measure dietary adherence. A dietary assessment is an interpretation of information obtained about an individual's diet. The dietary assessment is often necessary to inform, guide and evaluate nutritional management of T2D. Recording food intake has two functions: 1) to self-monitor behavior as part of self-management; 2) analyze nutrition intake for outcome assessment for individuals, groups or populations (Burke et al., 2005). According to Gibson 2005, methods used to measure an individual's food intake can be categorized into two groups. Recalls or records, such as 24-h recall and food record, are referred to as "quantitative daily consumption methods," and are designed to measure the estimated quantity of an individual's food intake over one or more days. Retrospective methods, such as diet history and food frequency questionnaire, are used to recall food intake over a long period of time in the past, and these methods are designed to measure food patterns (Gibson, 2005). All dietary assessment methods are subject to inherent error, which can be random or systematic. Random errors can occur to anyone and can be the result of skipping a question or forgetting to report a food item. Systematic errors refer to over or under-reporting dietary intake or respondent bias related to personal characteristics (Willett, 2013). Although the natural limitations of dietary intake assessment exist, dietary assessment methods are needed to estimate usual intake and measure diet quality.

1.2.6.1 The 24-hour recall method

In a 24-h recall, subjects are asked to recall and report their intake, including all food and beverages, consumed in the previous 24 hours. Because of large within-person variations in dietary intake, research suggests that in order to assess usual intake, multiple recalls are necessary to get an estimate of usual dietary intake (weekdays and weekends) (Willett, 2013). 24-h recall can be obtained by face-to-face, telephone, or computer based interview (Rutishauser, 2005). There are disadvantages and advantages to the 24-h recall method. The main disadvantage is that this method does not capture habitual intake unless multiple days are recorded. The main advantage is a higher response rate due to the relatively low subject burden compared to the other methods mentioned below such as diet history or food records (Rutishauser, 2005). Because of relatively quick and easy administration of 24-h recall, it is used in large national population based surveys such as the Canadian Community Health Survey - Nutrition (CCHS) (Health Canada, 2012), the National Health and Nutrition Examination Survey (NHANES) in the United States (Briefel, 1994), and the Australian National Nutrition Survey (Australian Bureau of Statistics, 1995).

1.2.6.2 Food records

In order to obtain a food record, subjects are asked to record all foods, beverages, and amounts consumed over a specified time period (preferably at the time of consumption). Household measuring cups, spoons, and scales may be used to aid in the precision of the record. Usually subjects are trained in advance to fill out the record accurately and completely (Willett, 2013). Because of the high subject burden, 1-4 days is generally regarded as adequate to describe dietary intake. This method is advantageous because it does not rely on memory, uses household measurements, and reflects actual intake. This method is disadvantageous because the process of measuring or weighing can be time-consuming for the participant (Rutishauser, 2005). Despite these limitations the food record method is considered to be the most precise technique to estimate usual intake (Willett, 2013). The British National Diet and Nutrition Survey used 7-day food record until 2001 (Whitton et al., 2011). Fyfe et al. (2010) found that three days weighed intakes recorded can produce accurate intake compared with 7 days weighed intakes recorded.

1.2.6.3 Diet history

The diet history method tries to obtain a measure of someone's typical eating pattern. This method combines an interview obtaining a usual pattern, a 3-day food record, and a questionnaire that assesses certain food groups (Willett, 2013). This method is advantageous because it provides an estimate of habitual intake. It is disadvantageous because it requires a high skill level from the interviewer, and also can be very time consuming (Rutishauser, 2005). Diet histories are often used in a clinical setting to estimate usual intake for an individual over a long period time but this method is unsuitable for large population studies because of high subject burden. Diet history provides good estimates of energy and macronutrient intakes in a sample group with T2D (Martin, Tapsell, Denmeade, & Batterham, 2003). Interestingly, computerized diet history assessment in patients with T2D captures more foods compared with traditional diet history conducted by dietitians (Probst, Faraji, Batterham, Steel, & Tapsell, 2008).

1.2.6.4 Food Frequency Questionnaire

The Food Frequency Questionnaire (FFQ) attempts to estimate a subject's "usual" frequency of food consumption over a specified period of time (Willett, 2013). The FFQ asks respondents what they eat, how often they eat it, the portion sizes they eat food in, and can be used to derive an estimate of an individual's nutrient intake. The FFQ can consist of only a few items (Semi-FFQ) intended to measure specific nutrient intake patterns or as many as 200 items to measure total daily nutritional intake. This method is advantageous because it is inexpensive to distribute. It is disadvantageous because of the amount of measurement error that can occur. The FFQ has been widely used in large epidemiological studies such as Women's Health Study (Kushi et al., 1992), the Nurse's Health Study (London SJ et al., 1989), the European Prospective Investigation into Cancer and Nutrition (EPIC) Study (Kroke et al., 1999), and the Japan Public Health Center-based Prospective Study (Oba et al., 2013). The FFQ method was also used to estimate usual intake pattern of Brazilian patients with type 2 diabetes (Sarmento, Riboldi, Rodrigues, Azevedo, & Almeida, 2013), and to assess diets of Koreans with T2D

(Hong et al., 2010). Recently, the Dietary Questionnaire for Epidemiological Studies has been validated in adults with type 1 and type 2 diabetes patients against a 3-day weighed food record and 24-hour urinalysis. There was a weak to moderate correlation between FFQ and 3-day weighed food record and 24-h urinalysis. However, the tool is applicable to use in group level analyses (Petersen, Smith, Clifton, & Keogh, 2015). Although FFQ has been used widely in epidemiology studies, FFQ is becoming less popular in nutrition research because of the type of error associated with FFQ. In Subar et al. 2015 review, they recommended not using self-report dietary intake as measure of energy intake due to the random and systemic error.

1.2.7 Short dietary assessment tools for diabetic patients

Dietary assessments for diabetic patients are usually measured with a 24-h recall in research or clinical settings because it is easy to collect individual dietary data (Willett, 2013). Dietary assessment methods, including 24-h recalls, require analysis by a health professional (Rutishauser, 2005). Because of the subject burden of traditional dietary methods and the cost of analysis, development of short instruments to help clinical staff identify dietary patterns and guide counselling is an emerging dietary methodology. Calfas, Zabinski, & Rupp (2000) conducted a review to identify 18 dietary measures that could potentially be used in a primary care setting. All of the instruments measured fat, while some measured cholesterol, fruits, vegetables, and fiber. More recently a systematic review conducted by England, Andrews, Jago, & Thompson (2015) identified dietary assessment tools that could be suitable for use in clinical practice for the management of obesity, CVD, and T2D. Twenty-seven tools were described in the review, which variously assessed healthy eating or healthy dietary patterns, adherence to the Mediterranean diet, dietary fat intake, and vegetable and/or fruit intake. Only one study conducted by Godin, Bélanger-Gravel, Paradis, Vohl, & Pérusse (2008) assessed fruit and vegetable intake among obese and non-obese Canadians. Table 1-1 summarizes ten short dietary assessment tools that have been tested in T2D, obese, high risk of CVD or high cholesterol populations. Six of these tools were developed in the USA, one in Canada, one in France, one in Australia, and one in Spain. Three of these tools were tested in hypercholesterolemic patients, three with high risk of CVD, two in T2D patients, and two in obese patients.

Table 1-1 Short dietary screening tools used in cohorts of type 2 diabetes patients or others with metabolic diseases

Tool name, authors, year of publication, and country	Nutrients, , foods or dietary patterns assessed	Sample characteristics (sample, age gender, ethnicity, BMI, diseases)	Tool characteristics (language, number of questions, portion estimates, time to complete	Outcomes	Strengths	Weaknesses
NLSChol questionnair e Beliard et al 2012 France	o Saturated fat o Unsaturated fat o Meat o Dairy products o Fish & seafood o Fruits & vegetables o Bread & carbs o Products with phytosterols	o N= 58 validity o N= 1048 reliability o Age 60.9±15.5 yr o Male 55% o Female 45% o Ethnicity NR o BMI 26.9±6.5 kg/m^2 o T2D o hypercholesterolemia o hypertension o hypertriglyceridemia	o French o 11 questions (food frequency) o Portion described as weight o 5 minutes	o Criterion validity with FFQ r=0.3 Kappa 0.48 o Cronbach α =0.69	o Assessed diet adequacy for hypercholesterolemic patients o Easy to calculated and interpreted o Can be used for cardiovascular assessment	o Questionable internal consistency o NLSChol questionnaire did not predict change in cholesterol
Latino Dietary Behaviours Fernandez et al 2011 USA	o Healthy dietary changes o Artificial sweeteners o Number of meals o Fat c/onsumption	o N=252 o Age 55.2 ± 11.2 yr o Male 23.,4% o Female 76.6% o Ethnicity Hispanic o BMI 34.7± 6.9 kg/m^2 o Diabetes	o Spanish o 13 questions (food frequency & behaviour) o Completion time NR	o Factor analysis explained approximately 47% of variance. Tool concurrent o Validity with three 24-hr recall r=-0.42 to -0.02	o Assessed 4 eating behaviour in T2D. o Used three 24-hr recall o Detected greater change in behaviour for intervention o Large sample size o Quick tool can be used in clinical setting	o LDBQ did not predict change over time in biological outcomes o Sample was primarily women, Spanish-speaking, low-income, low-education o Response options do not offer a "not applicable"

Rate Your Plate Gans et al., 1993 USA	○ Four food groups ○ Oil, sweets & snack	○ N=102 ○ Age 38.1±13.1 yr ○ Male 42.2% ○ Female 57.8% ○ Ethnicity White 90% ○ BMI 27.8±5.9 kg/m^2 ○ hypercholesterolemia	○ English ○ 23 questions (food frequency and behavioural)	○ Criterion validity with 136-item FFQ r=-0.28 to -0.48	○ Large sample size ○ Using four food groups to estimate the quality of diet ○ Focus on fat intake ○ Easy to calculate	○ Estimate fat intake ○ Used FFQ for comparison, 24-hr or biomarker are preferable method of validation ○
Canada Fruits and Vegetables questionnair e Godin et al 2008 Canada	○ Fruits and vegetables ○ Fruit juice	○ N= 103 obese ○ Age NR ○ Male 46.6% ○ Female 53.4% ○ Ethnicity NR ○ BMI 34.5 ± 4.1 kg/m^2	○ French ○ 7 questions (food frequency)	○ Criterion validity with FFQ r=0.66 ○ Criterion validity with FFQ r=0.65 ○	○ Large sample size ○ Used two dietary method to validate the questionnaire ○	○ Used FFQ for comparison, 24-hr or biomarker are preferable method of validation ○
Dietary Fat Quality assessment Kraschnews ki et al 2013 USA	○ Meat processed ○ Meat ○ Nuts ○ Dairy products ○ Oil ○ Condiments ○ Salad dressing	○ N= 120 ○ Age 51.0±0.7 yr ○ Male 0% ○ Female 100% ○ Ethnicity White, Black ○ BMI 38.0±0.4 kg/m^2 ○ T2D	○ English ○ 20 questions (food frequency) ○ Portion described as servings ○ 6 min	○ Criterion validity with 125-item Fred Hutchinson Cancer Research Center–Food Frequency Questionnaire r=0.66 to 0.38 ○ Reliability r=0.48 to 0.59	○ Assessed monounsaturated fat, polyunsaturated fat, and omega- 3 fatty acid ○ Useful for clinical counselling	○ Did not assess fruit and vegetables ○ Used FFQ, 24-hr or biomarker are preferable method of validation ○ Cannot be generalized has been tested on women with low-income

Diet Quality Tool O'Reilly et al 2012 Australia	○ Fruits & vegetable ○ Bread ○ Fat ○ Starchy food ○ Breakfast cereal ○ Meat ○ Fish ○ Salt ○ Unhealthy foods & takeaway meals	N=37 Age 61.2 ± 10.8 yr Male 86% Female 14% Ethnicity NR BMI 28.7± 4.1 kg/m^2 Heart attack or mild stroke	English 13 questions (dietary consumption, dietary habits, food choice) 11 min	Criterion validity with 4-day food diary r= 0.374 to 0.559	○ Used for those at high risk of CVD. ○ Provided information about dietary behaviour changes ○ Used a 4-day food diary ○ Quick & simple tool can delivered by non-nutritionist ○ Cut-off of 60% of total score to determine better diet ○ Low burden ○ Potentially used in clinical setting	○ Small sample size ○ Bias selections ○ Validity of the tool is limited to saturated fat, fibre and omega-3 fatty acid intakes
Starting the Conversation Paxton et al 2011 USA	○ Fast food ○ Fruits & vegetables ○ Soda drink ○ Beans, fish, chicken ○ Snacks, high fat ○ Desserts ○ Oil	○ N= 372 ○ Age 58.4±9.2 yr ○ Male 50.3% ○ Female 49.7% ○ Ethnicity Multi-ethnic ○ BMI 34.8±6.5 kg/m^2 ○ T2D	○ English ○ 8 questions (food frequency & behaviour) ○ Completion time NR	○ Construct validity with fat screener r= 0.39 to 0.59	○ STC was stable over time ○ Used in clinical setting ○ Large sample	○ The tool has not been validated against a criterion standard of dietary intake (e.g., 3-day dietary recalls)
Northwest Lipid Research Clinic Fat Intake Score Rerzlff el al., 1997 USA	○ Meat ○ Daary products ○ Eggs ○ Dessert ○ Snacks ○ Cooking fats	○ N= 310 ○ Age 42.5±19.7 yr ○ Male 62.5% ○ Female 37.5% ○ Ethnicity White 90% ○ BMI 27.8±5.9 kg/m^2 ○ hypercholesterolemia ○ hypertriglyceridemia	○ English ○ 12 questions (food frequency and behavioural) ○ Portion described as weight ○ 3 min	○ Criterion validity with 4 food records r=-0.30 to 0.60	○ Used 4-day records ○ Identify people who are in high-fat and high cholesterol diet ○ Easy to calculated ○ Large sample size ○ Reflect dietary intake overtime	○ Does not estimate the calorie intake ○ Target only hypercholesterolemic patients

Short Mediterranean diet adherence Schroder et al 2011 Spain	○ Olives oil ○ Fruits & vegetables ○ Meat ○ Oil ○ Soda drink ○ Wine ○ Pulses ○ Fish & seafood ○ Pastry ○ Nuts	○ N=7146 ○ Age 67 ○ Male 42.8% ○ Female 57.2% ○ Ethnicity NR ○ BMI 30 kg/m^2 ○ High risk CVD	○ Spanish ○ 14 questions (food frequency & behaviour) ○ Completion time NR	○ Criterion validity with 137-items semi-FFQ k =0.81 to 0.03 ○ Moderate correlation r=0.52 between overall score and FFQ	○ Determine adherence to the traditional Mediterranean diet ○ Cut-off points for the consumption of food items ○ Questionnaire was correlated with BMI, WC, and cardiometabolic risk markers	○ Over-estimation of validity given the likely correlation in error between both methods ○ Can not be generalized because participants were older participants at high risk for CHD
Fat and Fiber Behaviour Questionnaire Shannon et al 1997 USA	○ Avoidance of fat ○ Low fat foods ○ Low fat meat ○ Replace high fat foods with F&V ○ Replace meat with beans ○ Cereal and grain ○ Fruits and vegetables	○ N= 1795 validity ○ N= 943 reliability ○ Age 51 ○ Male 32% ○ Female 68% ○ Ethnicity 93% white ○ BMI NR ○ Illness NR ○	○ English ○ 29 questions (food frequency and behavioural)	○ Criterion validity with 94-items FFQ r=0.20 to 0.53 ○ Reliability r=0.64 to 0.74	○ Large sample size ○ Measure intervention outcome ○ Measure food frequency and behaviours	○ Participants well-educated ○ Mostly women and white ○ Used FFQ for comparison, 24-hr or biomarker are preferable method of validation

Abbreviations: NR-Not recorded; BMI – body mass index; STC Starting the Conversation ; WC – waist circumference

1.2.8 Need for an adequate measure for use in research

In research studies, adherence to dietary recommendations is assessed using many different approaches, and there is little consistency in how researchers interpret recommendations and apply them to dietary data. In the reviews mentioned (Calfas et al., 2000; England et al., 2015), and in reviewing the literature, researchers did not identify a tool simultaneously assessing adherence to the Canada Food Guide (CFG) (Health Canada) and Canadian Diabetes Association recommendations (Dworatzek et al., 2013) in individuals with T2D. The existence of an appropriate, validated tool measuring the adherence to CFG and CDA recommendations is required to measure diabetic patients' perceptions of their dietary adherence.

1.2.8.1 Questionnaire Development

Development of a valid, reliable questionnaire that assesses diabetic patients' perceptions of their dietary adherence according to CDA guidelines and Canada's Food Guide needs to follow a process designed to ensure its utility as well as its reliability and validity. Rattray & Jones (2007) describes the process of designing and developing questionnaires that are supported by "a logical, systematic and structured approach". After development, questions should be submitted for further review to an expert in the field and pre tested on a small sample size to determine which questions to retain (Rattray & Jones, 2007). It is necessary for a nutrition questionnaire to have established effectiveness before being used in practice. Therefore, the reliability and validity of the nutrition questionnaire must be established in advance of using the questionnaire.

1.2.8.2 Questionnaire Validation

Validity assesses the ability to measure what it is designed to measure. There exist several simple ways of testing for content, criterion-related, and construct validity. The first step in creating a valid questionnaire is to ensure its content validity. Content validity is usually tested during tool development, as it relates to the selection of variables for the tool. Face validity, which is a basic test of this form of validity "describes a set of items that assess what they appear to measure on their face" (DeVellis, 2012). Experts in the field who assess the content questions can determine face validity. Criterion-related validity assesses the accuracy of the questionnaire measures, which is test the association between an items or scale with a gold standard scale (DeVellis, 2012). This is usually assessed through having the same subjects complete the newly-developed nutrition tool, as well as a second method of measuring nutritional status in the population (usually 24-h recall), and then examining the correlation between the two methods (Jones, 2004b). Construct validity is a type of validity that assesses how well the nutrition tool matches the theoretical expectations of how it should act prior to beginning its development (Jones, 2004b).

1.2.8.3 Questionnaire Reliability

Reliability assesses the repeatability and internal consistency of the questionnaire, making sure that all items within the questionnaire measure a similar concept. This means obtaining similar results for the same individual across different times and/or settings. Two simple ways to measure reliability of a questionnaire are through test-retest consistency and internal consistency. One test-retest measure of reliability is the coefficient of stability. This form of reliability describes as the consistency of the tool when one individual completes the screening tool on two or more separate occasions. Statistically, there are several ways to assess reliability. Paired samples t-tests can be used to see whether or not the difference in scores between the two administrations is significant or not. Another commonly used method to assess reliability is Pearson's correlation of the data between administrations. Wilcoxon signed-rank test is used for categorical data, and kappa statistic is used for dichotomous variables (Jones, 2004a). The internal consistency measures how well items of the test relate with one another. Internal consistency is typically measured by Cronbach's coefficient alpha (α). Cronbach α can identify which questions are not grouped correctly. The acceptance cut-off of Cronbach α is 0.70 or higher (DeVellis, 2012).

1.2.9 Measuring efficacy vs effectiveness in nutrition interventions

Efficacy is defined as the performance of an intervention under highly controlled conditions; whereas an effectiveness study measures the performance of an intervention in real-world practice (Singal, Higgins & Waljee, 2014). Studies designed to test efficacy are carried out under highly controlled conditions such as in a randomized control trial design. An effectiveness study takes place in settings such as community-based project implementation. In term of patient population, an efficacy study uses strict inclusion and exclusion criteria; therefore, the ability to generalize results is limited. On the other hand, an effectiveness study involves a more heterogeneous population (Singal, Higgins & Waljee, 2014). These designations of *efficacy* and *effectiveness* are often used in drug studies. When these terminologies are applied to clinical nutrition studies, a feeding study is an example of an efficacy trial, meanwhile, a community or national level as well as cost-effectiveness studies are examples of effectiveness trials (Compher, 2010). In the real world, when a person is diagnosed with diabetes, health care providers provide diabetic patients with information and tools to empower to diabetic patients to manage their diabetes. The PANDA project provided diabetic patients with a 4-week menu plan (a tool), and education sessions to help them to adhere the CDA nutrition therapy. Thus the PANDA project is testing the effectiveness of the menu plan.

1.2.10 Nutrition risks, adherence and interventions for diabetic patients

Nutrition has been recognized for its importance in contributing to the health of populations, particularly for groups at risk of nutrition-related health problems, such as people with diabetes. Poor nutritional status has been linked to increased rates of obesity, glucose intolerance and T2D amongst African Americans (Jen, Brogan, Washington, Flack, & Artinian, 2007). In another study high diet quality scores characterized by high intakes of plant-based foods, moderate intake of alcohol and low intakes of red and processed meat, sodium, sugar-sweetened beverages, and trans fat were associated with a lower risk of T2D (Koning et al., 2011). An analysis of three large cohorts, the Nurses' Health Study (1984-2008), the Nurses' Health Study II (1991-2009), and the Health Professionals Follow-up Study (1986-2008) was conducted by the Harvard group. The study examined whether individual fruits are differentially associated with risk of T2D. The study found that three servings/week of blueberries, grapes, and apples were significantly associated with a lower risk of T2D; meanwhile, consumption of fruit juice was associated with a higher risk (Muraki et al., 2013).

Many studies in different countries around the world have shown that diabetes patients have poor dietary adherence to the recommendations. A study conducted by Eilat-Adar et al. (2008) evaluated how well American Indians with diabetes from Strong Heart Study (SHS) met dietary recommendations compared with U.S. adults with diabetes in the NHANES. The analysis showed that saturated fat and sodium intake was higher than the recommendation in both cohorts; meanwhile, fiber intake was lower than the recommendation in the NHANES study. Analysis of the Canadian Community Health Survey, 2007–2008 was by De Melo, de Sa, & Gucciardi (2013) to explore sex differences in diabetes self-care and medical management in the Canadian population. Among those with diabetes, more women than men met their daily intake of fruits and vegetables (20.4% vs. 11.8%, respectively); however, among those without diabetes, more women than men met their daily intake of fruits and vegetables (23.8% vs. 11.3%, respectively). Although no difference was reported in fruits and vegetables intake between those with or without diabetes, the study suggests that women were more likely to have a healthier food and nutrient profile than men with diabetes. A cross-sectional study conducted in 2008–2010 among 609 individuals with T2D in Spain assessed adherence to nutritional recommendations of the European Association for the Study of Diabetes (EASD) and American Diabetes Association (ADA). The analysis showed that SFA and MUFA were high, but trans fat intake was relatively low. Carbohydrate intake and fibre were relatively low; meanwhile, sugar intake was high. Intakes of cholesterol and sodium were also high (Muñoz-Pareja et al., 2012). Analysis from the Japan Diabetes Complications Study including 1,516 patients with T2D aimed to clarify dietary intake among Japanese diabetic individuals. Diabetes patient aged 60 years or over meeting nutritional recommendations for total fat, SFA, fiber, and sodium were 33%, 27%,16%, and 46% respectively (Horikawa et al., 2014).

1.2.10.1 Nutrition intervention benefits for T2D

The literature describes nutrition interventions as the nutrition education that addresses the issues for populations. The goals of nutrition education for diabetes are the facilitation of "voluntary adoption of eating and other nutrition-related behaviors conducive to health and well-being, and includes improving an individual's nutrition knowledge, modifying his/her eating behavior and improving physiological outcomes" (Wang, Song, Ba, Zhu, & Wen, 2014). Some programs are focused on increased participant nutrition knowledge (Wang, Song, Ba, Zhu, & Wen, 2014). Other types of programs are interactive and allow the participants to have an opportunity to share and learn from each other and to participate in activities like preparing and tasting healthy foods (Archuleta, VanLeeuwen, Halderson, Wells, & Bock, 2012).

Several studies have documented the benefits of lifestyle modification for preventing T2D or improving weight loss, glycemic control, and CVD risk factors with patients already diagnosed with T2D. The Finnish Diabetes Prevention Study (Tuomilehto et al., 2001), the US Diabetes Prevention Program (Knowler et al., 2002), and the China Da Qing Diabetes Prevention Study (Li et al., 2008) have shown that intensive lifestyle interventions that combine diet and exercise are at least as effective as pharmacotherapy for reducing the incidence of diabetes (Knowler et al., 2002; Li et al., 2008; Jordi Salas-Salvadó et al., 2011; Tuomilehto et al., 2001). Further support for the role of lifestyle in T2D management has been documented in the Look AHEAD (Action for Health in Diabetes) study. The Look AHEAD intervention focused on a minimum weight loss of 7% of initial body weight during the first year. Caloric restriction was the primary method of achieving weight loss as well as increasing physical activity level to 175 min of moderate intensity physical activity per week. A clinically significant weight loss was associated with improved diabetes control and CVD risk factors (Look AHEAD Research Group et al., 2007). After 4 years of follow-up, the study demonstrated that intensive lifestyle intervention sustained weight loss, reduced the level of hemoglobin A1c in the bloodstream, and improved both blood pressure and lipid profile (Look AHEAD Research Group & Wing, 2010). Anderson et al. (2003) conducted a meta-analysis of 18 studies that assessed lifestyle modification induced weight loss after 12 weeks in patients with T2D. The inclusion criteria of 18 studies were: obese diabetic subjects with BMI > 30 kg/m^2; adults 18 years old; energy-restricted diets; achievement of mean weight losses of > 5%. The analysis showed that weight loss was associated with an improvement in glycemic control, blood pressure, and lipid profile among diabetic patients. The Mediterranean-style diet with foods of low GL may also affect glycemic control in T2D. A study conducted by Esposito, Maiorino, Di Palo, Giugliano, & Campanian Postprandial Hyperglycemia Study Group, (2009) examined the adherence of to a Mediterranean diet and glycemic control in T2D patients. Adherence to the Mediterranean diet was assessed by a 9-point scale, with a higher score indicating greater adherence. Diabetic patients with the highest scores (6-9) had lower body mass index (BMI), waist circumference, and A1c compared with lower scores. The vegetarian diet also has the potential to manage diabetes. Kahleova and colleagues found that a calorie-restricted vegetarian diet improved insulin sensitivity compared to a conventional diet over 6 months. They concluded that the effects may due to the weight loss (Kahleova et al., 2011).

1.2.11 Behavior change theories and strategies

Behavior change theories and strategies are used to facilitate the aspects of nutrition interventions related to behavior change. Theories most frequently used in nutrition education interventions are the Social Ecologic Theory, The Health Belief Model, the Stages of Change Model, the Theory of Meaningful Learning, the Information Processing Model, and the Social Cognitive Theory (Bales, Locher, & Saltzman, 2014).

1.2.11.1 Social Cognitive Theory

Social Cognitive Theory (SCT) is one of the oldest and most studied behavior change theories in nutrition. SCT posits that a person will change their behavior through practice with feedback, support and positive reinforcement (Bandura, 1986). The key elements of SCT include reciprocal determinism (the interaction of the person, behavior, and the environment), behavioral capability (knowledge and skills), expectations (the desired outcome), self-efficacy (becoming more proficient), observational learning (learning from others' behavior), and reinforcements (factors that strengthen the desired behavior).

1.2.11.2 Examples of interventions based on SCT

SCT is commonly used in diabetes exercise or nutrition interventions and community-based diabetes education programs. For example, the First Step Program (FSP) was a pedometer-based intervention conducted in Canada. The intervention was based on SCT and was designed to compare the effectiveness of lifestyle physical activity program delivered to individuals with T2D by professionals versus peers. After 16 weeks, there was a statistically significant increase in physical activities, reduction in weight loss, and improvement in blood pressure in both groups (Tudor-Locke et al., 2009). Allen (2004) conducted an integrative literature review to determine the ability of SCT in diabetes exercise research to predict the exercise behaviors and to identify key interventions that enhance exercise initiation and maintenance. Ten out of thirteen studies reported a statistically significant relationship between self-efficacy and exercise behavior. Mixed results were found from the 8 studies regarding the ability of SCT to predict exercise behavior outcomes (Allen, 2004). A systematic review conducted by Jang & Yoo (Jang & Yoo, 2012) assessed the effect of SCT on enhancing self-efficacy in disease management in Koreans with chronic disease. Among the 20 studies, 11 identified diabetes mellitus as the condition of interest. A lack of consistent results regarding the effect of SCT on enhancing self-efficacy in disease was found. Inconsistent results may due to methodological flaws such as small sample size or program components strategies. A study conducted by Chapman-Novakofski & Karduck (2005) examined diet knowledge before and after a community-based diabetes education program based on SCT. They reported a significant improvement in knowledge, health beliefs, and self-reported behaviors such as used herbs in place of salt, cooking with olive or canola oils, and using artificial sweeteners in baking.

1.2.11.3 Other characteristics of successful behavioral interventions for diabetes

T2D management is quite complex, and the use of a theory such as the Social Cognitive Theory, the Theory of Meaningful Learning, and the Information Processing Model can improve knowledge and skills that are necessary for diabetes management (Merrill RM, Friedrichs M, & Larsen L, 2002). The review of Muchiri, Gericke, & Rheeder (2009) demonstrated the effectiveness of nutrition education programming for adults with T2D in resource-poor settings and low-income groups. The authors suggested elements that contribute to successful nutrition education program include interventions tailored to the needs, abilities and socio-cultural background of the patient, the active involvement of the patient, an appropriate nutrition education content and approach, social support to participants, suitable delivery methods individual/group approaches, and suitable program duration. A systematic review was conducted by Glazier, Bajcar, Kennie, & Willson (2006) to identify and synthesize evidence about the effectiveness of interventions to improve diabetes care among socially disadvantaged populations. The authors stated that high intensity programs (10 hours) delivered over a long duration (≥ 6 months) were effective, based on clinical outcome.

To promote behavior changes, various strategies are used in nutrition interventions including goal-setting, self-monitoring and problem-solving. (Muchiri et al., 2009) suggests that inclusion of strategies that actively engage T2D patients including group discussion, goal-setting and problem solving, role-playing, story telling, cognitive reframing (ie. identifying and then disputing irrational or maladaptive thoughts) and meal preparation can be effective. These strategies have been shown to improve knowledge and change dietary behavior such as healthy food choices and eating habits (Muchiri et al., 2009).

1.2.12 Nutrition Education Techniques

Nutrition education techniques are critical to consider when designing components of diabetes interventions. Nutrition education may be done using individual or group methods, and may be face-to-face or computer-generated. There is inconsistency in the literature as to which is more effective, individual or group counseling. A systematic review conducted by Spahn et al. (2010) found that only three RCTs evaluated individual versus group counseling targeted to weight or diabetes management. These studies have shown that group counseling is more effective than one-on-one counseling. A more recent review Chomutarea, AArsanda, & Hartvigsenb (2015) included 14 RCTs with diabetes patients, and concluded that the majority of the studies did not find a significant difference between group and individual counseling. From that review, only two studies concluded that individual is better than group counseling (J. Sperl-Hillen et al., 2011; Vadstrup, Frølich, Perrild, Borg, & Røder, 2011), and two studies concluded that individual is better than group counseling (Hwee, Cauch-Dudek, Victor, Ng, & Shah, 2014; Merakou, Knithaki, Karageorgos, Theodoridis, & Barbouni, 2015). In J. Sperl-Hillen et al. (2011) study a better outcome was documented with individual counseling, including A1c, SF-12 physical health score, nutrition score, and physical activity score. Lower completion rates were noticed in the group counseling, which could be indicative of patient preference for individual counseling. Another study conducted by Vadstrup et al. (2011) found a greater improvement in glycaemic control, and reduction CVD risk factors with individual counseling, possibly due to higher attendance. A study conducted by Hwee et al. (2014) found that people attending group classes had fewer acute diabetes complications than those enrolled in individual classes. The authors explained the difference in outcome may have been due to the longer duration of the classes, the information received in the class being rated as more “useful” by patients, and being able to share problems with other patients. Another study conducted by

Merakou et al. (2015) found that group educational programming using Conversation Maps improved A1c and HDL more than an individually counseled cohort; however, this result was confounded by lower A1c levels before the intervention in the group educational programme cohort.

1.2.13 Curriculum information and educator qualifications

Most nutrition interventions highlight information regarding the role of nutrition in chronic diseases, dietary recommendations for the disease, reading and understanding nutrition labeling, grocery shopping techniques, increasing physical activity, problem solving techniques and new cooking skills. The Diabetes Prevention Program taught basic information about nutrition, physical activity, and behavioral self-management with a 16-session course for patients at high risk of diabetes (The Diabetes Prevention Program, 2002). The first 8 sessions were about modifying energy intake and increasing energy expenditure. The last 8 sessions were about the psychological, social, and motivational challenges in maintaining lifestyle behavioral changes. In the Finnish Diabetes Prevention Study, seven dietary advice sessions were given by trained nutritionists with advice to consume more than 50% of daily calories from carbohydrates, less than 10% from saturated fat and 20% from mono- and polyunsaturated fat, less than 300 mg daily cholesterol, and 15 g per 1000 kcal of fiber (Uusitupa et al., 2000).

As the prevalence of chronic diseases related to aging, obesity, and lifestyle practices is increasing, the demands for nutrition training of health care professionals is essential to improve patient care and population health (Kris-Etherton et al., 2014). Education interventions usually are conducted by trained individuals from professions including nursing, dietetics, physiotherapy, exercise physiology, psychology (Reddy, Vaughan, & Dunbar, 2010) or doctor (J. M. Sperl-Hillen et al., 2010). However, Spahn et al. (2010) state that registered dietitians and dietetics practitioners usually conduct nutrition counseling with clients to facilitate behavior change because they are the most knowledgeable in nutrition and diverse ethnic cuisines. However, other models of education delivery have also been tried. A review conducted by Tang, Ayala, Cherrington, & Rana (2011) examined the impact of volunteer-based peer support interventions on diabetes-related health outcomes. The result of this review was inconsistent findings. Some studies found that peer-led interventions are as effective as professional-led interventions, other studies had little evidence that peer-led interventions are effective. For example, glycemic control was reported in six RCT studies. Two studies reported improvements in glycemic control in peer-led group compared to the control group (Heisler & Piette, 2005; Lorig, Ritter, Villa, & Piette, 2008), and four studies did not differ between the two groups. In Lorig et al. (2008) study did not expect that peer-led interventions are more effective than professional-led interventions. One possible explanation is that peer facilitators may encourage participants to choose behaviors that are “right” for them. In Heisler & Piette (2005) study it was explained that the majority of participants enjoyed talking with their peers and participated regularly in the peer support calls. For this reason peers may be more effective than nurse facilitators.

1.2.14 Dietary approaches to weight loss and management of diabetes

There are many dietary strategies when it comes to controlling hyperglycemia, managing weight loss, and reducing CVD risk for T2D patients (Ajala et al., 2013). These strategies typically include reducing the number of calories consumed, meal replacement strategies, meal preparation strategies, and carbohydrate counting. The CDA nutrition therapy guidelines recommend that diabetic patients follow the CFG in order to meet their nutrition requirements.

1.2.14.1 Calorie restriction for weight loss

A diet focusing on calorie restriction is a core lifestyle intervention strategy for losing weight. This could be achievable by creating calorie deficits of 500 calories/day (Miller et al., 2002). Norris et al. (2004) conducted a meta-analysis to assess the effectiveness of low calorie diets in weight control in adults with T2D over the long term (at least 12 months). Twenty-two studies of reduced calorie weight loss interventions using loss strategies such as dietary advice, physical activity, or behavioral interventions have been identified. A total of 4659 participants were analyzed. The combined outcome was a modest decline in weight (-1.7 kg (95% CI, -0.3 to -3.2 kg)) and A1C levels (-0.3% (95% CI -0.8 to- 0.2)) in intervention compared with the control groups. Usually, individuals will gain back their weight after the initial weight loss. After an intervention, the individual should pay attention to dietary choices and exercising that can help maintain weight loss intervention (Blomain et al., 2013).

1.2.14.2 Meal replacement

Weight loss programs for people with diabetes may utilize a meal replacement strategy, which usually consists of provisions of set portions of controlled meals fortified with vitamins and minerals. Replacement products usually replace 1 or 2 meals per day in the diet plan. Randomized controlled feeding trials have shown that meal replacement is effective for weight loss and improving glycemic control among overweight people with T2D (Cheskin et al., 2008; Yip et al., 2001). Yip et al., 2001 conducted a study to evaluate the safety and feasibility of using liquid meal replacement among T2D patients. Participants were randomized into one of the three diet-plans: meal replacement containing lactose, fructose, and sucrose; meal replacement in which sucrose and fructose were replaced by free sugar; and standard diet. All groups received diets of similar macronutrient composition. After 12 weeks, liquid meal replacement was show to be effective in weight loss and improved glycemic control and lipid profile. Cheskin et al., 2008 enrolled 112 overweight or obese adults with T2D randomized to a 25% energy-deficit diet in accordance with standard diet or portion-controlled diet plus meal replacement. Both groups received diets of similar macronutrient composition. The portion-controlled diet group received approximately 50% to 60% of their caloric intake from meal replacements, while standard diet group received their calories requirement from foods. Each patient met 3 times for individual consultations with a dietitian, and 17 group educational sessions during the weight loss phase, and 13 group educational sessions during the maintenance phase. After 34-weeks, weight loss among portion-controlled diet was 6.84% (7.3 ± 6.2 kg) versus 3.70% (3.7 ± 3.2 kg) among standard diet group. There was a trend to reduced A1c among meal replacement diet participants; yet A1c among standard diet participants increased.

1.2.14.3 Prepared meals

Another strategy that nutrition researchers and practitioners use for weight loss trials is to provide participants with meals. Participants in this type of study are provided with foods and beverages, which they must consume. Look AHEAD Research Group (2007) conducted a randomized trial to evaluate the effect of a prepared meals program in T2D patients. The study showed that there were improvements in glycemic control and CVD risk factors in individuals with T2D who consumed prepared meals. Another randomized trial provided prepared meals for patients with hypertension, dyslipidemia or T2D. After 10 weeks, there were improvements in lipids, blood sugars, and weight loss among the intervention arm compared with the usual care group (Haynes et al., 1999). Dasgupta et al. (2012) developed a program that combined self-monitoring strategies such as weight change, step counting, and cooking skills training. Seventy-two obese adults with T2D were enrolled in a 24-week program. The program consisted of 15 sessions. In all sessions, participants prepared meals under a chef's supervision, and they discussed eating behaviours/nutrition with a registered dietitian. After 24 weeks, there were reductions in total energy and sodium intake. Weight Efficacy Life-Style Scores improved, indicating better ability to control eating behavior, as well as physical activity. There was also a reduction in weight, A1c, and blood pressure. Meal preparation and cooking skills program had an effect on improving eating behavior, glycemic control, blood pressure, and weight loss among T2D patients (Dasgupta et al., 2012).

1.2.14.4 Menu planning

There are many sources of information for menu planning, including books/e-books, and the Internet. However, many of these menu plans lack rigorous and unbiased empirical evidence. A small number of studies have tested commercial programs in obese subjects (Hutchesson et al., 2014; Jebb et al., 2011). In addition, small studies have been conducted in Canada testing a menu plan in diabetic patients (Bader, Gougeon, Joseph, Da Costa, & Dasgupta, 2013; Soria-Contreras, Bell, McCargar, & Chan, 2014). A 24-week Internet-based menu-planning program has confirmed clinically significant reduction in weight and improvement in glycemic control and blood pressure (Bader et al., 2013). A 12-week printed menu plan that incorporated the CDA's nutrition therapy guidelines and considered environmental factors has shown a clinically significant reduction in A1c, reduction weight loss, and improvements in lipid profile (Soria-Contreras et al., 2014). Focus group interviews were conducted to qualitatively assess facilitators and barriers to implementing the menu. The main barrier was that following the menus was more time consuming compared with eating ready-to-eat food. Another barrier was the ingredients required for every week were perceived as excessive. Facilitators for using menu plan included: increased frequency of snacking, to having healthier foods available at home, and enhanced portion control. An additional facilitator was adopting healthier eating habits including learning how to eat more healthily, planning meals, and decreased food wastage (Soria-

Contreras et al., unpublished data). The menu plan was therefore shown to be feasible and effective for diabetes management.

1.2.14.5 Web-based interventions

Technology has been used in nutrition interventions, and it has been suggested that web-based interventions are more effective in causing behavioral change compared to non-Web-based interventions (Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004). Web-based technology has been used in managing diabetes and weight loss. A recent systematic review evaluated the impact of Web-based telemonitoring for managing T2D. Fifteen out of nineteen studies showed clinical improvement in A1c ranging from 0.6% to 2.2% (Mushcab, Kernohan, Wallace, & Martin, 2015). Arem & Irwin (2011) conducted a review of web-based weight loss interventions in adults. By reviewing the studies, they found that the effectiveness of web-based weight loss interventions ranged from no weight loss to an average loss of 7.6 kg. This may due to variations in terms of sample size, study duration, and curriculum content between the interventions. Another reason is that a high dropout rate was documented in some studies, indicating low feasibility and utilization of some web-based programs.

1.2.14.6 Carbohydrate counting

Because carbohydrate is the major macronutrient that affects blood sugar, diabetic patients have to consume carbohydrates carefully. Carbohydrate counting is a method of monitoring carbohydrate intake. Bergnstal et al, (2008) randomized 273 subjects with T2D using a simple algorithm to adjust either mealtime insulin or carb counting. After 24 weeks of the intervention, both arms yielded a reduction of about 1.5% in A1C with no significant differences in mean A1C change from baseline. Research indicates that carbohydrate counting has a positive effect on many areas of diabetes treatment including improving A1c and reducing weight gain (Bergenstal et al., 2008).

1.2.15 Barriers and facilitators for adherence to a diabetic diet

A healthy diet is vital to diabetes treatment and glycemic control to avoid complications. Clinical Practice Guidelines outlined by the CDA (2013) provides information on nutrition therapy for the effective management of diabetes (Dworatzek et al., 2013). However, new diabetic patients face difficulties integrating a new dietary pattern into their lifestyle and find it to be the hardest and most challenging aspect of diabetes self-management (Nagelkerk, Reick, & Meengs, 2006; Whittemore, Chase, Mandle, & Roy, 2002). Evidence for this difficulty is supported by low adherence to dietary recommendations. Many studies in different countries around the world have shown that diabetes patients had poor dietary adherence to the recommendations (Eilat-Adar et al., 2008; Rivellese et al., 2008; Rowlands & Huffman, 2007; Thanopoulou et al., 2004).

Understanding the barriers and facilitators for adherence to a diabetic diet is important to the design of a nutrition intervention. There are several reasons individuals do not adhere to a diabetic diet. Barriers range from lack of knowledge and understanding of the diet plan, family and social barriers, lack of cultural acceptability, and the cost of recommended foods.

1.2.15.1 Barriers to adherence

Rustveld et al. (2009) found that men with T2D had difficulties incorporating nutritional recommendations into their daily life. Some barriers were difficulties applying portion size restrictions to everyday practice, and eating healthy during weekends, holidays and when travelling. Vijan et al. (2005) identified barriers to adherence to dietary recommendation in T2D patients in urban and suburban areas. The most common barrier was cost followed by small portion size, lack of family and social support. Nthangeni et al. (2002) used a mixed method design to understand dietary practices, knowledge, and barriers to compliance of black South Africans with T2D. They found that diabetic patients had confusion regarding portion size, and the types of foods they were told to eat. (Marcy, Britton, & Harrison, 2011) identified barriers to appropriate dietary behaviors in low-income patients with T2D. The most important factors in food selection were taste and cost. Stress causing over-eating or unhealthy food choices, difficulty resisting unhealthy food, and healthy foods being too expensive were the greatest barriers to appropriate dietary behavior. Results from the Cross-National Diabetes Attitudes, Wishes and Needs (DAWN) Study reported that psychological conditions such as depression, anxiety, stress, and burnout had a negative effect on performance of self-management behaviors (Peyrot et al., 2005). (Chlebowy, Hood, & LaJoie, 2010) identified barriers to self-management of T2D among Americans in an urban community. The time consumed by the disease, lack of self-control at social events, and memory failure in daily activities such as taking medication or eating were perceived barriers.

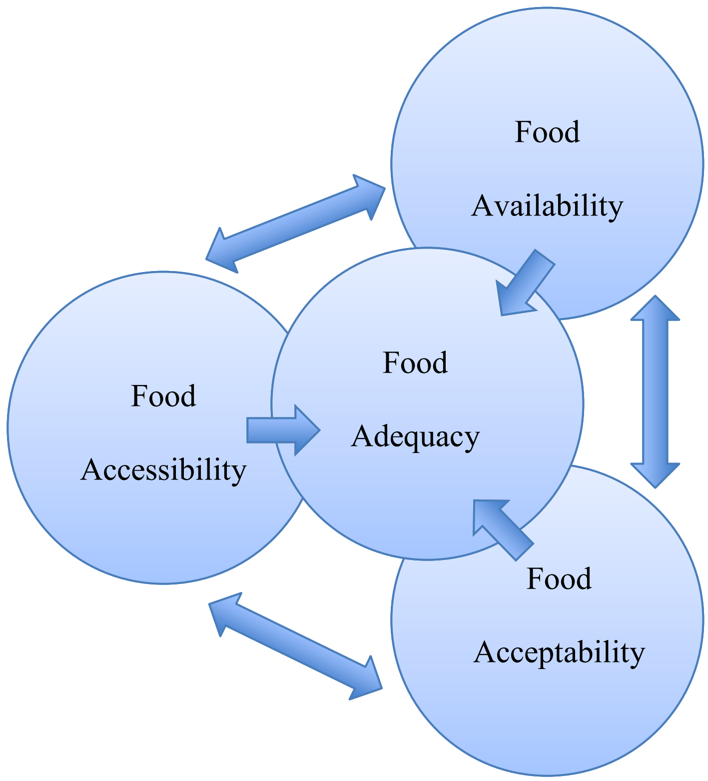
1.2.15.1.1 Barriers related to the food environment

Some researchers have tried to identify environmental barriers to dietary adherence. The 4-A Framework, derived from the food security literature, suggests that foods recommended in nutrition programs should be adequate, accessible, acceptable and available. Adequacy means the diet meets guidelines that lead to better primary (blood glucose control) and secondary outcomes (reduce complications, eg. kidney failure). Accessible refers to the financial and physical accessibility of foods. Foods must be acceptable from multiple perspectives: hedonic qualities, culture, traditions and usual consumption habits. Finally, foods must be generally available to the consumer population of interest, e.g., locally grown or regularly imported (Food and Nutrition Technical Assistance Project & Riely, 1999).

Figure 1-1 illustrates the inter-relationships between elements of the 4-A Framework. Food adequacy is central to the model and cannot be achieved if the other three As are not met. Thus, to ensure that food intake meets nutritional guidelines, recommended foods should be accessible, acceptable and available. However, simply having food available in stores does not mean that it is economically or physically accessible, for example for those of low socioeconomic status lacking transportation. Low-income, diabetic, older adults reported that availability of food in Edmonton was not a barrier; however, poor diet quality was still detected (Asaad, 2012). Food insecure diabetic patients reported that they were more likely to put off buying food to have sufficient money for testing supplies, and diabetes medication (Seligman, Davis, Schillinger & Wolf, 2010). Conversely, availability can be a problem as noted in low-income neighborhoods, where fresh fruits and vegetables were less likely to be found (Godwin & Tegegne, 2006; Latham & Moffat, 2007; Zenk et al., 2005). Physical accessibility may also influence the purchase of recommended foods. Being elderly with diabetes may restrict mobility. Sharkey (2004) documented that over 90% of homebound Mexican-American elderly people reported being physically unable to shop, cook, or feed themselves, and 58% reported food insecurity, meaning that they did not have enough money for food.

Lack of cultural acceptability is another important barrier for dietary adherence and has an impact on diet choices and food preparation. Just because food is available does not mean that it is acceptable. Evidence from a qualitative study found that British Bangladeshis with T2D did not choose foods based on western notions of food values, but based on cultural values (Chowdhury, Helman, & Greenhalgh, 2000). Another qualitative study documented that Surinamese patients with T2D in Netherlands eating traditional Surinamese food faced difficulties in changing their dietary behaviors to meet dietary guidelines (Kohinor, Stronks, Nicolaou, & Haafkens, 2011). The physical and economic accessibility of ethnic foods may also influence food choice. Arabic and South Asian immigrant women in Edmonton reported that physical accessibility and the high cost of traditional food are barriers to ethnic foods consumption (Vallianatos & Raine, 2008). Food availability, accessibility and acceptability barriers could emerge in particular in diabetic populations, and influence their adherence to current nutrition recommendations.

Figure 1-1 4-A Framework inter-relationships



The availability of recommended foods for people with diabetes may influence food choice. Several studies have demonstrated that fresh fruits and vegetables were often unavailable in low-income area supermarkets (Godwin & Tegegne, 2006; Latham & Moffat, 2007; Zenk et al., 2005). The availability of food for low-income, diabetic, older adults was measured in Edmontonians. The results demonstrated that older adults had poor diet quality; participants in this study consumed fewer fruits and vegetables (Asaad, 2012).

The physical and economic accessibility of recommended food for diabetics may also influence food choice. Being elderly with diabetes may restrict access to recommended food. Sharkey (2004) documented that over 90% of homebound Mexican-American elderly people reported being physically unable to shop, cook, or feed themselves, and 58% reported food insecurity, meaning that they did not have enough money for food. The diabetic diet has to be nutritionally adequate in terms of quantity, quality, and variety. However, many studies have shown that diabetes patients have poor dietary adherence to the recommendations.

Lack of cultural acceptability is considered another important barrier for dietary adherence and has an impact on diet choices and food preparation. Evidence from a qualitative study found that British Bangladeshis with T2D did not choose foods based on western notions of food values, but based on cultural values (Chowdhury, Helman, & Greenhalgh, 2000). Another qualitative study documented that Surinamese patients with T2D in Netherlands eating traditional Surinamese food found that they faced difficulties with changing their dietary behaviors to meet dietary guidelines (Kohinor, Stronks, Nicolaou, & Haafkens, 2011). Vincent, Clark, Zimmer, & Sanchez (2006) found that Mexican Americans with T2D have difficulties following a diabetic diet because the dietary advice given was not tailored to Mexican culture. Dietary interventions have to be a culturally tailored for people in ethnic minority groups with T2D. A systematic review found that culturally tailored interventions have improved glycemic control, lipid profile, weight and blood pressure among participants with T2D, compared with those receiving usual care in short and long-term. Culturally tailored interventions also increase the knowledge about diabetes, and patients gained healthier lifestyles (Attridge, Creamer, Ramsden, Cannings-John, & Hawthorne, 2014). A study translated the dietary guidelines of the ADA into a culturally tailored nutrition program based on the Korean Diabetes Association for Korean American immigrants with T2D. Culturally relevant intervention materials such as Korean food models, and individual tailored nutrition counseling were used. Almost all of the participants were satisfied with education program, but anthropometric measurement was not assessed to determine the clinical benefits of the program (Song et al., 2010).

1.2.16 Need for intervention for Albertans with type 2 diabetes

As discussed above, the rates of T2D have increased dramatically worldwide and in Canada in the last few decades. Similarly, diabetes is a large and growing health problem for Albertans. There were approximately 147,498 Albertans with diabetes in 2007, and prevalence is predicted to reach 513,433 people in 2035 (Lau, Ohinmaa, & Johnson, 2011). Therefore, the burden on the health care system is higher due to sheer numbers plus the additional health problems present in the aging population. The estimate of total healthcare cost for diabetes in Alberta in 2035 is predicted to be $2.27 billion (Lau et al., 2011). Provision of effective behavioural interventions for people with diabetes can contribute to improved outcomes and reduced complications, which will have the twin benefits of better quality of life for patients and reduced costs to the healthcare system and society.

The effectiveness of nutrition intervention for prevention of T2D, and improving weight loss, glycemic control, CVD risk factors with patients already diagnosed with T2D is supported by peer-reviewed, published literature as discussed in Section 1.2.9.1. A core curriculum intervention addressing environmental barriers may facilitate patient adoption and adherence to dietary recommendations. Menu planning and grocery list use have been an effective strategy for weight control as well as diabetes management (Bader et al., 2013; Cunningham et al., 2006). To our knowledge, no studies have used menu planning that also took into consideration food environmental factors (nutritionally adequate with foods that are available, accessible, and acceptable). Therefore, the PANDA team developed a four-week menu plan to meet the CDA nutrition therapy guidelines and to facilitate adoption of healthy eating among type 2 diabetic patients. Optimal glycemic control is fundamental to the management of diabetes, and to minimize the risk of diabetic complications. We sought evidence for the effectiveness of 4-A Framework-based menu planning combined with supportive education on diabetes outcomes. A pilot-test of 15 participants conducted to test the feasibility and efficacy of programming and menu planning targeted to Albertans to improve diabetes outcomes found reductions ($p<0.05$) in A1c (-1%), weight (-2.6 kg) and improvement in HDL by +0.2 mmol/L after 3 months (Soria-Contreras et al., 2014). Focus group interviews conducted to qualitatively assess facilitators and barriers to implementing the menu plan showed that the menu plan was acceptable and useful for the participants (Soria-Contreras et al, unpublished data). As the prevalence of diabetes in Alberta increasing, it is essential to develop an intervention for Albertan taking into consideration the 4-A Framework to target improvements in dietary intake. Best practices suggest that incorporating a structured education program with multiple opportunities for skill-building and increasing knowledge, as well as peer support will facilitate behavior change.

1.3 Objective

The overall objective of the present Ph.D. thesis was to evaluate the effectiveness of the PANDA menu plan plus education sessions among T2D clients in terms of diet quality and adherence and clinical improvement in glycemic control. The specific aims were:

1. To measure the reliability of Perceived Dietary Adherence Questionnaire and its validity relative to three repeated 24-h dietary recalls among T2D patients. (Chapter 2)
2. To evaluate the effectiveness of the menu plan plus education sessions among people with T2D in improving glycemic control and diet quality and adherence. (Chapter 3)
4. To identify the main food sources of sodium, saturated fat and added sugars among T2D patients and influence of the PANDA intervention on food choices affecting intake of those nutrients. (Chapter 4)

Chapter 2. The Reliability and Validity of the Perceived Dietary Adherence Questionnaire for People with Type 2 Diabetes

2.1 Introduction

There has been an increase in the incidence of diabetes worldwide. Over 347 million individuals have diabetes and it is estimated that by the year 2030, 552 million people will be living with diabetes (International Diabetes Federation, 2013). In Canada, 2.4 million people had diabetes in 2009 and by 2019 the number is expected to reach 3.7 million (Public Health Agency of Canada, 2012). The economic burden of diabetes in Canada is estimated to rise from $6.3 billion annually in 2000 and to $16.9 billion in 2020 (Canadian Diabetes Association, 2012). Nutrition therapy is a crucial part of type 2 diabetes treatment and self-management. It has been well documented that improving dietary intake can reduce glycated hemoglobin (A1c) (Kulkarni et al., 1998; Pi-Sunyer et al., 1999), improve clinical outcomes, and mediate weight loss (Franz et al., 1995; Pi-Sunyer et al., 1999). The Canadian Diabetes Association (CDA) (Dworatzek et al., 2013) recommends that diabetic patients to follow Eating Well with Canada's Food Guide (CFG) (Health Canada, 2007) in order to meet their nutrition requirements. Additional recommendations include limiting saturated fat and restricting added sucrose plus fructose to 10% of total energy while increasing consumption of low glycemic index foods, high-fiber foods, monounsaturated fats and foods rich in n-3 fatty acids (Dworatzek et al., 2013).

While clinical outcomes such as A1c and blood pressure can easily be monitored by the medical team treating the diabetic patient, assessing dietary intake and creating a longitudinal record of dietary intake is not as practical (Calfas, Zabinski, & Rupp, 2000). However, being able to monitor a health outcome and provide timely feedback to the patient may help achieving in long-term adherence to dietary goals (Jaacks et al., 2014). Dietary intake is usually assessed by 24-h recalls, food frequency questionnaires (FFQ) or food records. These instruments require administration and analysis by a skilled health care professional (Rutishauser, 2005). Therefore, these instruments are not suitable for quick assessment by health care providers. They may also impose a significant patient burden (Calfas et al., 2000; Jaacks et al., 2014; Rutishauser, 2005). Furthermore, these instruments are not specific for diabetes diet recommendations; therefore, the questionnaires may not be sensitive enough to assess how well a patient is adhering to a prescribed dietary pattern. For example, our previous study found no significant change in the Healthy Eating Index score calculated from 3-day food records after 12 weeks of following a menu plan for diabetes, despite significantly lower body mass index, waist circumference and A1c (Soria-Contreras, Bell, McCargar, & Chan, 2014). A shortcoming of the Healthy Eating Index is that it was not developed for people with diabetes; it incorporates general food guide serving recommendations but not specific diabetes recommendations. Few studies have developed a questionnaire to measure the adherence to disease-relevant guidelines (Pullen & Noble Walker, 2002; van Lee et al., 2012) or specific diets (Béliard et al., 2012; Mochari, Gao, & Mosca, 2008) and there is no short questionnaire to measure a combination of the adherence to CFG (Health Canada, 2007) and CDA recommendations (Dworatzek et al., 2013) in individuals with type 2 diabetes. Therefore, the Perceived Dietary Adherence Questionnaire (PDAQ) was developed by PANDA team to measure diabetic patients' perceptions of their dietary adherence. The present study aimed to measure the reliability of PDAQ and its validity relative to three repeated 24-h dietary recalls.

2.2 Experimental section

2.2.1 Subjects

Data from the Physical Activity and Nutrition for Diabetes in Alberta (PANDA) intervention study (ClinicalTrials.gov registration NCT01625507) were used to test internal consistency and validity. Briefly, 73 participants were enrolled in the dietary intervention

(Cohort I). Participants were recruited through a variety of avenues including posters, word-of-mouth, contact via a list of potential participants maintained by the Alberta Diabetes Institute and via an article about the project in a local newspaper. The inclusion criteria were: people diagnosed with type 2 diabetes and able to read and speak English. The exclusion criteria were: having severe gastrointestinal issues, type 1 diabetes or kidney disease. Anthropometric measures (height, weight, waist circumference), A1c, blood pressure, serum lipids, 24-h recall repeated on three successive days, and PDAQ were obtained at baseline and three months.

Subsequently, additional type 2 diabetes patients (n = 27, Cohort II) were recruited through poster and database of the Alberta Diabetes Institute to measure the test and retest reliability of the PDAQ with a one-week interval. The inclusion and the exclusion criteria were the same as for the intervention study. The University of Alberta Human Research Ethics Board approved both studies. Written informed consent was obtained from all participants.

2.2.2 Perceived Dietary Adherence Questionnaire

The PDAQ was adapted from the Summary of Diabetes Self-care Activities measure (Toobert, Hampson, & Glasgow, 2000). The questionnaire was modified according to CFG (Health Canada, 2007) and the CDA Nutrition Therapy recommendations in place in the 2008 Clinical Practice guidelines (Dworatzek et al., 2013). To test item clarity, four experts were involved in reviewing the questionnaire items and the PDAQ was pre-tested on 10 non-diabetic volunteers. Questions raised by the pre-test cohort were addressed prior to using PDAQ in a research cohort.

The questionnaire consists of a total of nine questions structured to cover the CDA Nutrition Therapy guidelines (Dworatzek et al., 2013) with reference to following CFG (Health Canada, 2007) : overall adherence to CFG, recommended fruits and vegetables servings, consumption of low glycemic index carbohydrate-containing foods, high sugar foods, high fiber foods, n-3 fatty acids, healthy (monounsaturated) oils, and high fat foods. One item addresses appropriate carbohydrate spacing. The response is based on a seven-point Likert scale to answer the question phrased as “On how many of the last 7 days did you : : : ?” (Table 2-1). Higher scores reflect higher adherence except for items 4 and 9, which reflect unhealthy choices (foods high in sugar or fat). For these items, higher scores reflect lower adherence, therefore, for computing a total PDAQ score, the scores for these items were inverted. Although based on a weekly timeframe, it was anticipated that the PDAQ would reflect usual dietary patterns based on knowledge that most people consume similar foods from week to week (Salvini et al., 1989)

Table 2-1. Diet Perceived Adherence Questionnaire

Item	Response
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 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?	0 1 2 3 4 5 6 7
3. 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
4. On how many of the last SEVEN DAYS did you eat foods high in sugar, such as cakes, cookies, desserts, candies, etc.?	0 1 2 3 4 5 6 7
5. On how many of the last SEVEN DAYS did you eat foods high in fibre such as oatmeal, high fiber cereals, whole-grain breads?	0 1 2 3 4 5 6 7
6. On how many of the last SEVEN DAYS did you space carbohydrates evenly throughout the day?	0 1 2 3 4 5 6 7
7. 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
8. 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
9. 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

* Scoring: to obtain the total PDAQ score, the responses for items 4 and 9 were first inverted, e.g., a score of 7 becomes 0, then add all of the responses together. The maximum score was 63.

2.2.3. Assessment of dietary intake

Baseline dietary intake of Cohort I was measured by three 24-h dietary recalls (2 weekdays and 1 weekend day) using an internet-based questionnaire (WebSpan), which has been shown to reduce assessment error and bias (Storey & McCargar, 2012). Daily records were screened for duplicate entries for a single food item. Participants were excluded from the analysis if they did not complete three 24-h dietary recalls or implausible total energy values were reported (outside the range of 500–3500 kcal/day for women and 800–4000 kcal/day for men) (Willett, 1998). The average daily total energy, macronutrient intake and intake from the four food groups described in CFG was obtained from WebSpan based on the 2001b Canadian Nutrient File database (Health Canada, 2001), and used for analysis. To calculate the Healthy Eating Index (HEI) (Garriguet, 2009) the food items reported by the participants and macronutrient analysis from WebSpan were used. Glycemic index (GI) score was calculated by following formula (daily GI = GL/net carbohydrate - 100). GI values were obtained from two databases (Foster-Powell, Holt, & Brand-Miller, 2002; The Univerity of Sydney, 2015). Carbohydrate spacing was measured by calculating grams of carbohydrate consumed at each meal and snack (Canada Diabetes Association, 2008), then giving a score from 1 to 6, where 1 represented poor spacing of carbohydrates (all in one meal) and six represented excellent spacing of carbohydrates (at least 15 g per meal and snack). PDAQ takes approximately 5 min for participants to complete and one minute to calculate the score, which was based on a maximum of 7 for each item (with the items for consumption of foods high in sugar and fat inversely scored), for a total maximum score of 63.

2.2.4 Statistical methods

Statistical analyses were performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA), Statistical significance was set at $p < 0.05$. Descriptive statistics were used to summarize demographic data. The mean ± SD was calculated for continuous variables, and percentage for categorical variables. Comparison of demographic characteristics between the first cohort (used to test validity) and the second cohort (used to do test-retest reliability) was assessed by Chi square and unpaired t-tests as appropriate. Spearman rank-order correlation coefficients were calculated between PDAQ questions to determine if the perceived adherence to CFG question score (Question (1)) correlated with the scores of Questions (2) through (9).

Validation: After screening the food intake data for implausible dietary intake or incomplete three 24-h dietary recalls, nine participants were removed ($n = 64$). Normality of nutrient intake distributions was checked statistically. If the normality assumption failed, data were log10-transformed. The questions of the PDAQ were individually correlated with specific information derived from the three 24-h dietary recalls (i.e., mean servings of food groups, nutrient intakes, glycemic index). Specifically, the question related to CFG was correlated with the mean number of servings of the four food groups. The question related to fruits and vegetables consumption was correlated with the mean servings of fruits and vegetables. The question related to consumption of foods with low glycemic index was correlated with the mean glycemic index score. The question related to consumption of foods high in sugar was correlated with the average daily intake of added sugar. The question related to intake of foods high in fibre was correlated with the servings of whole grains. The question related to spacing carbohydrate throughout the day was correlated with the total carbohydrate spacing score. The question related to eating fish or foods high in n-3 fatty acids was correlated with the number of foods in the dietary recall that were high in n-3 fatty acids. The question related to using healthy oils was correlated with the intake of monounsaturated fatty acids. The question related to eating foods high in fat was correlated with the intake of total fat. The correlation coefficients were interpreted by using Dancey and Reidy's categorisation (Dasi, 2005).

Reliability: the intra-class correlation coefficient (ICC) was calculated as an indication of test-retest reliability and internal consistency was measured by Cronbach's α coefficient (Weir, 2005).

2.3 Results

A total of 73 participants were enrolled in the PANDA study, which provided data for validity testing and internal consistency, and 27 participants were separately recruited for test-retest reliability testing. The characteristics of the participants are reported in Table 2-2. There were no significant differences between demographic characteristics of participants in the first versus second cohort except for employment status ($p = 0.008$).

Table 2-2. Baseline characteristics of the first cohort (n=73) and the second cohort (n=27).

Characteristics	Cohort 1 (n=73)	Cohort 2 (n=27)	P-value
Age (years)	59.2 ± 9.7	62.8± 8.4	0.096
Duration of diabetes (years)	9.1 ± 8.3	11.8± 7.8	0.127
Gender, %			0.603
Male	53.4%	59.3%	
Female	46.6%	40.7%	
Ethnicity, %			0.223
White	87.7%	70.3%	
Other	12.3%	29.7%	
Education, %			0.376
High school or less	15%	7.4%	
More than high school	85*	92.6%	
Employment, %			0.008
Wages and salaries	56.2%	18.5%	
Household income, %			0.688
≥ $59,999	21.9%	18.5%	
≤$60,000	78.1%	81.5%	

The score for the PDAQ was normally distributed and ranged from 10 to 54. PDAQ scores were not statistically significant different between male (32.5 ± 10.6, n = 39) and female (32.9 ± 12.2, n = 34) participants. A significant positive correlation was found between PDAQ score and age with r = 0.46, 95% CI (0.19, 0.54), and inversely with weight with r = -0.36, 95% CI (-0.52, -0.05).

Total PDAQ scores were associated with nutrient intakes from the average of the three 24-h dietary recall and correlated moderately with HEI-score (r = 0.41, 95% CI (0.19, 0.54)), as well as with fruits and vegetables servings (r = 0.25, 95% CI (0.03, 0.50)). In contrast, total PDAQ scores were negatively correlated with added sugar intake (r = -0.32, 95% CI (-0.51, -0.12)) and saturated fat intake (r = -0.25, 95% CI (-0.46, -0.05)).

To test the validity, we associated individual items of the PDAQ with nutrient intakes from the average of the three 24-h dietary recalls adjusted for total calories (Table 2-3). Following CFG more days per week was associated higher intake of servings from a variety of the four food groups ($p < 0.05$). Perceived eating of the recommended servings of fruits and vegetables more days per week was associated with higher intake of fruits and vegetables reported in 24-h recalls ($p < 0.05$). Reported consumption of foods with a low glycemic index more days per week predicted lower glycemic load ($p < 0.05$). Reporting eating of foods high in sugar (e.g., cookies) on more days was associated with higher added sugar intake ($p < 0.01$). Perceived eating of foods high in fiber (e.g., oatmeal) predicted higher intake of whole grains ($p < 0.001$). Reported consumption of foods high in fat (e.g., fried food) on more days predicted higher fat intake ($p < 0.01$). No significant association was found for spacing carbohydrate, foods high in n-3 fatty acids, and healthy oils versus the actual intake.

Table 2-3 presents the correlations between following CFG more days per week (Question (1) of PDAQ) with each subscale (Questions (2)–(9)). Higher perceived adherence to following CFG was moderately correlated with higher intake of fruits and vegetables (r = 0.60, 95% CI (0.42, 0.73)), higher intake of foods with low glycemic index (r = 0.28, 95% CI (0.04, 0.48)), higher intake of foods high in fiber (r = 0.44, 95% CI (0.22, 0.61)), more likely to space carbohydrate throughout the day (r = 0.59, 95% CI (0.40, 0.75)), and higher intake of fish high in n-3 fatty acids (r = 0.27, 95% CI (0.08, 0.45)). Conversely, there were negative correlations between perceived adherence of following CFG and intake of foods high in sugar (r = -0.36, 95% CI (-0.55, -0.18)) and foods high in fat (r = -0.45, 95% CI (-0.63, -024)).

Table 2-3. Validity of Perceived Dietary Adherence Questionnaire (PDAQ) versus three 24-h dietary recalls

PDAQ Item	PDAQ Score, Mean ± SD (max 7)	24 h dietary recall item	Intake, Mean ± SD	Linear correlation coefficient between PDAQ Score and Intake
Following CFG	3.0±2.5	At least 1 serving per food group (max 4)	15.8±3.7	0.33*
F&V servings	4.1 ±2.3	F&V servings	4.9±1.9	0.30*
Low GI	3.6±1.9	Glycemic load	49.5±4.8	-0.30*
High Sugar Foods	2.7±2.2	Added sugar (g)	47.4±37.1	0.40**
High Fiber Foods	5.0±1.9	Whole grain serving	5.6±2.2	0.46***
Carb Spacing	3.5±2.6	At least 15 g carbohydrate per meal	189.7±78.1	0.24
Sources of n-3 FA	1.7±1.6	n-3 PUFA (g)	3.3±3.2	0.11
Healthy Oils	3.0±2.5	MUFA (g)	28.7±11.2	0.15
High Fat Foods	2.6±1.7	Total fat (g)	83.9±30.7	0.35**

N = 64 participants who completed three 24-h recalls. Abbreviations and explanation: CFG = Eating Well with Canada's Food Guide; F&V = Fruits and Vegetables; GI = glycemic index; Carb Spacing = Spacing carbohydrate throughout the day; FA = fatty acids; Healthy oils = consumption of foods like nuts, olive oil, canola oil; PUFA = polyunsaturated fatty acids; MUFA = monounsaturated fatty acids. Confidence intervals for significant correlations are reported in the text. * $p < 0.05$; ** $p < 0.001$; *** $p < 0.0001$.

Test and re-test reliability was assessed by the intra-class correlation. High correlations were obtained for five items on the PDAQ (fruits and vegetables, foods high in sugar, foods high in fiber, fish and other foods high in n-3 fatty acids, and healthy oils) as well as the total PDAQ score (Table 2-4). Cronbach's α was 0.78 with no significant change to the overall α with the deletion of any individual item.

Table 2-4. Reliability of Perceived Dietary Adherence Questionnaire using a test-retest protocol

PDAQ Item	ICC (95% CI)	Mean (SD)	T	P
CFG	0.22 (-0.21, 0.57)	0.11	0.30	0.76
F & V servings	0.85 (0.58, 0.91)	-0.51	-2.76	0.01
Low GI	0.73 (0.42, 0.90)	-0.07	-0.27	0.78
High Sugar Foods	0.76 (0.45, 0.91)	0.48	1.75	0.09
High Fiber Foods	0.81 (0.66, 0.92)	0.03	0.16	0.87
Carb Spacing	0.46 (0.24, 0.80)	0.22	0.56	0.58
Sources of n-3 FA	0.74 (0.52, 0.90)	0.00	0	1.00
Healthy Oils	0.78 (0.50, 0.91)	0.07	0.24	0.81
High Fat Foods	0.55 (0.46, 0.83)	-0.03	-0.12	0.90
Total PDAQ score	0.77 (0.59, 0.89)	-0.60	-0.40	0.69

Abbreviations and explanations: CFG = Eating Well with Canada's Food Guide, F&V = fruits and vegetables, Low GI = low glycemic index, Carb Spacing = Spacing carbohydrate throughout the day, FA = fatty acids, Healthy oils = consumption of foods like nuts, olive oil, canola oil

Table 2-5 presents the correlations between following CFG more days per week (question 1 of PDAQ) with each subscale (questions 2-9). Higher perceived adherence to following CFG was moderately correlated with higher intake of fruits and vegetables (r = 0.60, 95% CI [0.42, 0.73]), higher intake of foods with low glycemic index (r = 0.28, 95% CI [0.04, 0.48]), higher intake of foods high in fiber (r = 0.44, 95% CI [0.22, 0.61]), more likely to space carbohydrate throughout the day (r =0.59, 95% CI [0.40, 0.75]), and higher intake of fish high in n-3 fatty acids (r = 0.27, 95% CI [0.08, 0.45]). Conversely, there were negative correlations between perceived adherence of following CFG and intake of foods high in sugar (r = -0.36, 95% CI [-0.55, -0.18]) and foods high in fat (r = -0.45, 95% CI [-0.63, -024]).

Table 2-5. Spearman rank-order correlations between frequency of following Canada's Food Guide and other items in the Perceived Dietary Adherence Questionnaire (PDAQ)

PDAQ Item	CFG
CFG	--
F&V servings	0.604 **
Low GI	0.280 *
High Sugar Foods	-0.368 **
High Fiber Foods	0.414 **
Carb Spacing	0.594 **
Sources of n-3 FA	0.272 *
Healthy Oils	0.19
High Fat Foods	-0.453 **

Abbreviations and explanations: CFG = Eating Well with Canada's Food Guide, F&V = fruits and vegetables, Low GI = low glycemic index, Carb Spacing = Spacing carbohydrate throughout the day, FA = fatty acids, Healthy oils = consumption of foods like nuts, olive oil, canola oil*$p<0.05$, **$p<0.001$, ***$p<0.0001$

2.4 Discussion

The aim of this study was to establish the validity and reliability of a dietary assessment tool for people with type 2 diabetes that would be simple to administer and score, as well as reflect current recommendations for a diabetes diet. Overall, the PDAQ appears to be a useful indicator of adherence to CFG and diet quality. Compared with a repeated 24-h recall, it also appears to be valid for assessing adherence to recommended servings of fruits and vegetables, and foods that have low glycemic index, are high in sugar, fiber or fat. The test-retest reliability was acceptable.

Other authors have developed short questionnaires to assess intake of various foods or nutrients in the general population whereas the PDAQ is targeted to specific nutrition recommendations for diabetes. The correlation obtained for fruits and vegetables intake between PDAQ and 24-h recall is comparable to previous studies that found moderate correlation ($r = 0.36–0.65$) between fruits and vegetables and short food frequency questionnaires (Andersen, Johansson, & Solvoll, 2002; Osler & Heitmann, 1996) or seven-day food records (Hemiö et al., 2014). Likewise, other short questionnaires found similar moderate correlations with foods high in sugar, fat and fiber with food records or FFQs (Francis & Stevenson, 2013; Hemiö et al., 2014; Osler & Heitmann, 1996). Poorer correlation was found for foods low in glycemic index in our study compared to other studies, which used short food frequency questionnaires (Barclay, Flood, Brand-Miller, & Mitchell, 2008; Barrett & Gibson, 2010). The correlation between self-reported carbohydrate spacing and the carb spacing score derived from 24-h recalls was not significant, which may be due to lack of knowledge among diabetic patients (Watts, Anselmo, & Kern, 2011) as well as health care providers (Wynn, Trudeau, Taunton, Gowans, & Scott, 2010), who are thus unable to instruct patients in the technique. No significant relationship was observed between questions related to unsaturated fat and the actual intake of unsaturated fat, which is consistent with Francis and Stevenson´s questionnaire compared with a 4-day food diary (Francis & Stevenson, 2013). Overall, the PDAQ performed similarly to other short questionnaires and has the advantage of being specific for a particular population, patients with diabetes living in Canada.

We determined that PDAQ had acceptable internal reliability since Cronbach's α was 0.78 (Cronbach's α scores for subscales were also acceptable and ranged from 0.74 to 0.79). The test-retest correlation coefficient for the entire questionnaire was acceptable ($r = 0.76$) suggesting that the PDAQ score is stable over time. Test-retest administration of PDAQ produced good correlations for questions related to fruits and vegetables, foods high in sugar and fibre, fish or foods high in n-3 fatty acids, and healthy oils; meanwhile, questions related to spacing carbohydrate and foods high in fat had moderate correlations ($r = 0.40$ and 0.53, respectively). The question related to CFG had poor test-retest correlation ($r = 0.21$). Low and moderate ICC values in some individual scores are due to the intra-individual variability (Willett, 1998), which is likely to be greater in foods that are consumed less often (like fish in the prairie provinces of Canada). Low test-retest reliability for high fat foods is interesting, suggesting either that there is true variation in intake or that fat may be "hidden" in some foods, such as processed foods (Glanz, Brug, & van Assema, 1997).

The correlations produced in validity tests between following CFG more days per week and each subscale shows that the PDAQ ranked subjects quite well. We showed that reporting consistent following of CFG is more likely to be positively associated with the intake of low-caloric density foods, and negatively associated with high-caloric density foods. This finding indicates that the PDAQ is a good instrument to measure adherence to CFG recommendations. We were particularly interested in examining PDAQ's ability to assess intakes specifically mentioned in the CDA Nutrition Therapy Guidelines that may not be captured using scores like the Healthy Eating Index. PDAQ subscales for low GI foods, high sugar, fiber and fat foods were moderate predictors of intake substantiated by the 24-h recall data.

We also found correlations between PDAQ and demographic or biological variables. The positive relationship found between PDAQ and age is similar in direction to a previous study that examined the association between HEI and age (Garriguet, 2009). The diet quality of Americans older adults measured using HEI was better than younger and middle-aged adults (Hiza, Casavale, Guenther, & Davis, 2013). PDAQ scores were also significantly negatively correlated with weight, which is consistent with Pate and colleagues' finding that diet quality was inversely associated with weight status (Pate, Taverno Ross, Liese, & Dowda, 2015). There was no significant relationship observed between PDAQ and gender.

Several other short questionnaires for dietary assessment have been developed. Calfas and colleagues (2000) conducted a review to identify dietary measures that can be potentially used in a primary care setting. All of the instruments measured fat, and some of the instruments measured cholesterol, fruits, vegetables, and fiber. Pullen and Walker (2002) used the Behavioral Risk Factor Surveillance Survey to assess adherence to the Dietary Guideline for Americans among midlife and older rural women. The Dutch Diet Index (van Lee et al., 2012) and the Australian Recommended Food Score (Collins et al., 2015) were developed to measure the adherence to country-specific dietary guidelines. All the previous studies have assessed the reliability and validity of the instruments in the general population. Hemiö and colleagues (2014) developed a 16-Item Food Intake Questionnaire and used it in a type 2 diabetes prevention program in Finland to estimate daily nutrient intake in a primary health care setting. To our knowledge, there are no other comparable questionnaires to assess adherence to dietary diabetic recommendations for people with T2D in Canada. Therefore, PDAQ could be a useful tool for dietitians as well as practitioners who are not nutrition experts but who would like a snapshot of the dietary compliance of individuals with type 2 diabetes in Canada. It could also be easily adapted to other settings using the relevant disease and/or country-specific guidelines. In our ongoing research we are using PDAQ to assess longitudinal changes in dietary adherence in type 2 diabetes participants. Preliminary analyses suggest that PDAQ is useful for this purpose (Soria-Contreras & Chan, 2012).

One strength of our study is that we used three internet-based, 24-h dietary recalls to estimate dietary intake, a method that has less bias than some others (Storey & McCargar, 2012) and was also relatively simple for the participants to complete. The study developed a short, simple to administer and score questionnaire that covers the CDA Nutrition Therapy guidelines (Dworatzek et al., 2013) with reference to following CFG (Health Canada, 2007). Use of PDAQ could therefore reduce both client and practitioner burden but allow longitudinal monitoring of dietary adherence to recommendations. The study has some limitations that need to be recognised. This study has a relatively small sample size but some previous studies have validated dietary instruments with a similar number of participants (Barclay et al., 2008; Francis & Stevenson, 2013; Pate et al., 2015). However, the small sample size does limit our ability to conduct multivariate or subgroup analyses such as gender or age effects. All participants lived in an urban area, therefore, the result may not be generalizable to those living in rural areas. Another limitation is that participants in the intervention study were more educated and had higher income compared with the general population. Although this may not affect the validation study, our findings might be different if we apply it in a population with lower education and income. Finally, although the CDA does not have a specific recommendation for sodium, our studies such as that reported in (Soria-Contreras & Chan, 2012) consistently find sodium intake in excess of current Health Canada guidelines (Health Canada, 2012). An item related to sodium intake could be a useful addition to the PDAQ.

2.5 Conclusions

Following the CDA nutrition therapy guidelines is important for improving health outcomes in people with type 2 diabetes, but there is a need to develop practical and quick tools that help clinicians and researchers to assess adherence to these guidelines. We suggest that the PDAQ may be useful to accomplish this objective and that it can be implemented in research. It may be worthwhile to test the PDAQ in a clinical setting.

Chapter 3. Effectiveness of a Lifestyle Intervention in Patients with Type 2 Diabetes: The Physical Activity and Nutrition for Diabetes in Alberta (PANDA) Trial.

3.1 Introduction

Diabetes is a major global health issue with over 0.5 billion individuals projected to be diagnosed by 2030 (International Diabetes Federation, 2013). In Canada, by 2019-20 the number is expected to reach 3.7 million, approximately 10% of the population (Public Health Agency of Canada, 2012) with an estimated cost of $16.9 billion (Canadian Diabetes Association, 2012) to the Canadian health care system. The Canadian Diabetes Association (CDA) Clinical Practice Guidelines (CPG) provide evidence-based recommendations for nutrition therapy as part of effective diabetes management (Dworatzek et al., 2013). Nutrition therapy can reduce glycated hemoglobin (A1c) by 1-2%, improve serum cholesterol levels and facilitate weight management (Dworatzek et al., 2013). Despite these benefits, diabetic patients find it difficult to integrate a dietary pattern consistent with the recommendations into their lifestyle (Asaad & Chan, 2012; Nagelkerk, Reick, & Meengs, 2006). Thus, not surprisingly, diabetes patients have poor adherence to dietary recommendations (Jarvandi, Gougeon, Bader, & Dasgupta, 2011; Muñoz-Pareja et al., 2012). Personal factors that may be barriers to adherence include language and communication skills, lack of knowledge or motivation, taste preferences and cravings, cooking skills, and lack of family and social support (Aitaoto et al., 2015; Berry, Anders, Chan, & Bell, 2012). Acculturation, lack of cultural acceptability of recommended diets and the cost of recommended foods are also barriers to diabetic diet adherence (Aitaoto et al., 2015; Deng, Zhang, & Chan, 2013). Diabetes educators recognize that clients' ability to incorporate recommendations is affected by these factors but that many clients may not have strategies and tools to overcome these barriers (Berry, Chan, Bell, & Walker, 2012). Diabetes patients identified ongoing professional and peer support and multi-level programming as potential solutions to address barriers to behaviour change (Berry, Chan, et al., 2012).

Environmental barriers also affect dietary adherence. The 4-A Framework, derived from the food security literature (Food and Nutrition Technical Assistance Project & Riely, 1999), suggests that foods recommended in nutrition programs should be adequate, accessible, acceptable and available. Adequacy means the diet meets guidelines that lead to better primary (blood glucose control) and secondary outcomes (reduce complications). Accessible refers to financial and physical accessibility of foods. Foods must be acceptable from multiple perspectives: hedonic qualities, culture, traditions and usual consumption habits. Finally, foods must be generally available to the consumer population of interest, e.g., locally grown or regularly imported (Deng et al., 2013).

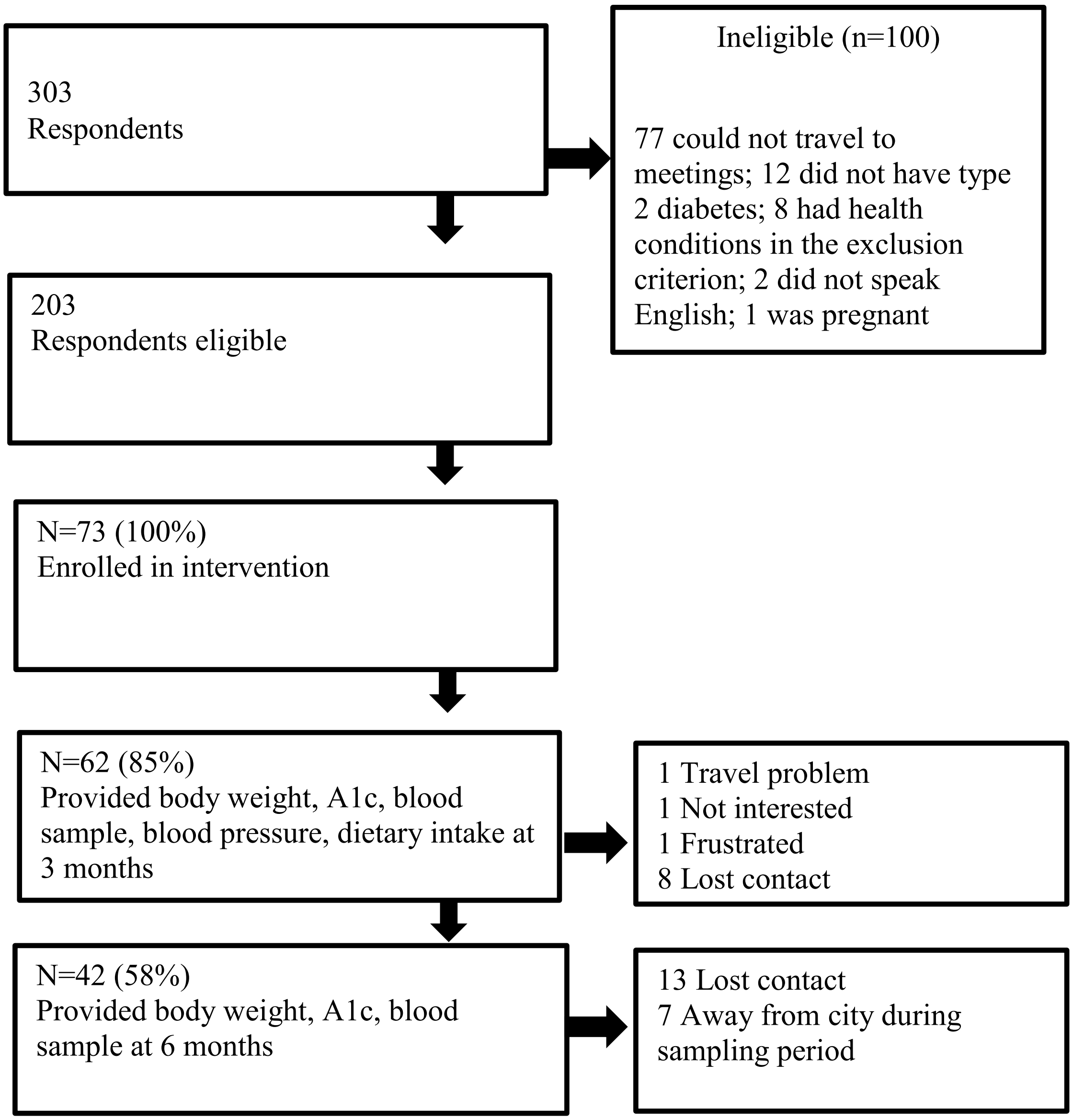
Another challenge for diabetic patients is translating nutrition recommendations into concrete operational plans such as food procurement, recipe selection, managing time to include food preparation, and budgeting (Ross & Geil, 2010). Menu plan and grocery list interventions are effective strategies for weight control as well as diabetes management (Bader, Gougeon, Joseph, Da Costa, & Dasgupta, 2013; Cunningham et al., 2006) but have not incorporated elements of the 4-A Framework. However, addressing environmental barriers may facilitate patient adoption of and adherence to dietary recommendations. To address this, a four-week menu plan based on the principles of the 4-A Framework was developed (Soria-Contreras, Bell, McCargar, & Chan, 2014) to meet the CDA nutrition therapy guidelines (Dworatzek et al., 2013). A phase 1 pilot-test of 15 participants conducted to test its feasibility and efficacy to improve diabetes outcomes found reductions ($p<0.05$) in A1c (-1%), weight (-2.6 kg) and improvement in HDL-C (+0.2 mmol/L) after 3 months (17). Focus group interviews conducted to qualitatively assess facilitators and barriers to implementing the menu plan showed that the menu plan was acceptable and useful for the participants (Soria-Contreras et al., 2014); Soria-Contreras et al, unpublished data). Hence, results of the pilot study justified a larger trial, this time incorporating a structured education program with multiple opportunities for skill-building and increasing knowledge, as well as peer support. The objective of this study was to evaluate the effectiveness of the menu plan plus education sessions among people with type 2 diabetes in improving glycemic control and promoting dietary changes.

3.2 Research design and methods

3.2.1 Participants

Participants were recruited for this study using posters hung in public places at the University of Alberta in Edmonton, word-of-mouth, email invitations sent to a contact list of potential participants maintained by the Alberta Diabetes Institute, and publicity by local media. There were 303 respondents who expressed interest in participating in this study (Figure 1), of whom 203 were deemed eligible based on a brief telephone interview. A personal screening interview was conducted to obtain demographic and baseline information. Participants were considered eligible if they self-identified as having T2D, could speak and write English, and attend Alberta Health Service diabetes education session. The exclusion criteria were: concomitant diseases or conditions that would preclude them following the menu plan, having type 1 diabetes, having severe diabetes complications such as kidney failure or being pregnant. The selection criteria were: ability to commit time to the study and able and willing to travel to weekly meetings (on Friday or Saturday) at the University of Alberta campus in Edmonton, Alberta, Canada. The research study also ensured that the study contained an equal number of males and females, as well as variation in A1c level, age, and ethnicity. In the event that more than 1 respondent met the selection criteria, the date of response was considered, with the earlier date preferred. Selection ceased once the required number of subjects was reached. An initial sample size of 51 participants was calculated (alpha=0.05, 1-beta=0.8, paired t-test) with the aim of detecting a 0.5% change in A1c, which was selected to be clinically relevant. Assuming a drop-out rate of 30% based on the pilot study (Soria-Contreras et al., 2014), 73 participants were enrolled into 5 small groups, with 12-14 people/group. To minimize drop out, the study coordinator used different strategies such as: following up with participants by phone and email, motivating participants (eg. setting a goal to achieve, active learning activities), reducing the burden of the study by providing complimentary parking in a nearby lot or paying for transit, keeping the session short, and allowing participants to choose either a weekend or weekday intervention timeslot. The study was conducted in the Human Nutrition Research Unit; all participants provided written, informed consent prior to starting the study. Protocols for this study were approved by the University of Alberta Research Ethics Board (ClinicalTrials.gov registration NCT01625507).

Figure 3.1 Participant recruitment and retention flow chart.



3.2.2 Study Design, Assessments, and Endpoints

This study was a single-arm, pre-post intervention study entitled Physical Activity and Nutrition for Diabetes in Alberta (PANDA) – Nutrition Arm. Participants completed assessments of dietary intake, physical activity, Diabetes Self-Efficacy Scale, and metabolic and anthropometric/health characteristics at baseline (following recruitment to the study and before the first educational meeting) and within 2 weeks following completion of the intervention. Participants were asked to list their drug intake and include: drug names (proprietary or generic), frequency of intake, and dose both pre- and post-intervention to assess the potential effect of intervention on their drug intake. Current dietary intake was assessed using three 24-h dietary recalls (2 weekdays and 1 weekend day) through a web-based questionnaire (Webspan; Storey & McCargar, 2012). Nutrient intake was determined by linking the food intake data to the Canadian Nutrient File (2001b, Health Canada, Ottawa, ON) after the food intake data had been carefully reviewed and cleaned to remove duplicate or implausible entries. Diet quality was assessed by calculating the Healthy Eating Index (HEI) adapted to the Canadian population (Garriguet, 2009). Participants' perceptions of their dietary adherence to CDA Nutrition Therapy Guidelines was assessed by the Perceived Dietary Adherence Questionnaire (PDAQ; 20) (Asaad et al., 2015).

Physical activity was assessed by a pedometer for 3 consecutive days. Instructions regarding use of the pedometer were given by the research coordinator at the time of the first meeting, and a sealed pedometer provided to each participant at the first and seventh meetings. The pedometer was attached to the belt or waistband of the participant's clothing. Participants wore the pedometers from the time of arising in the morning until bedtime during the monitoring period. Pedometers were removed during water-related activities (e.g., swimming, showering). After 3 days, participants were instructed to remove the seal and to email the study coordinator the total number of steps. The pedometers were retrieved from the participants at the second and eighth meeting. The Diabetes Self-Efficacy Scale (DSES) was used to measure participants' perceived confidence in performing self-care activities related to nutrition, exercise, glucose control and diabetes-related decision-making (Toobert, Hampson, & Glasgow, 2000). Changes in the DSES score between baseline and post-program assessment were used to assess potential influences in successful behavioral change.

Glycemic control was assessed using a finger prick blood sample (DCA 2000þ Analyzer; Bayer, Tarrytown, NY, USA). A1c values obtained on the DCA 2000þ Analyzer correlate well with standard laboratory values ($r=0.88$, $p<0.001$) with a mean difference of 0.2% (95% CI −0.1,–0.6%) (Pinhas-Hamie et al., 2010). The DCA 2000 Analyzer was calibrated according to the manufacturer's instructions by use of an optical test cartridge. The optimal normal low range for the A1c test is 4.4%- 6.6%, and we obtained a range from 5.2%-5.6%. The optimal normal high range is 8.6%-12.8%, and we obtained a range from 9.9%-11.7%.

Fasting (minimum 12 hours since last meal or snack) venous blood samples were collected to assess triglycerides (TG), total-C, LDL-C and HDL-C. Blood samples were centrifuged (3500 rpm), and serum was removed and frozen at -80ºC until analyzed using enzymatic colorimetric assays (Wako Chemicals, Richmond, Virginia, USA) for each metabolite.

Body weight was measured to the nearest 0.1 kg with the participant wearing light indoor clothing and without shoes using a digital scale (Health-o-Meter Professional Series; Sunbeam, Boca Raton, FL, USA), height was measured to the nearest 0.1 cm (Heightronic Digital Stadiometer; QuickMedical, Northbend, WA, USA) and body mass index (BMI) was calculated from height and weight measures. Waist circumference was measured to the nearest

0.1 cm with the participant in a standing position, with a non-stretch tape placed midway between the lateral lower ribs and the iliac crests after a moderate expiration. Body composition was measured using air displacement plethysmography (Bod Pod; COSMED USA, Concord, CA, USA). Blood pressure was determined following a 5-minute rest period with the participant seated, using an auto-inflated digital unit (UA-767CN; LifeSource, Japan). Blood pressure was measured 3 times, each two minutes apart, and the results averaged. All measurements were taken by trained personnel following standardized procedures.

3.2.3 Intervention

In accordance with best practices in nutrition interventions for diabetic patients, this study used Social Cognitive Theory as a theoretical model to guide the overall behaviour change intervention. This model emphasizes skill acquisition through practice with feedback, support and positive reinforcement (Bandura, 1986), goal-setting, self-monitoring and problem-solving as behavior change strategies. Weekly meetings approximately 1.5-2 hours in length were held at the Human Nutrition Research Unit in the Alberta Diabetes Institute, the University of Alberta. The curriculum consisted of five sessions (see Appendix 1): the first session focussed on Canada's Food Guide (CFG) food groups, serving sizes and number of recommended servings/day an open-ended discussion of facilitators and barriers to adhering to a dietary pattern consistent with CFG. Participants were encouraged to set individualized dietary goals based on review of their personal baseline dietary intake data (provided during the session) food groups and servings. The second through fifth sessions started with a discussion of participants' experiences and reflections on attaining dietary goals and factors that contributed to their dietary behaviours since the last session. At the end of each session, participants set new goals for the upcoming week, which they recorded in a workbook (Appendix 2). In session 2 the menu plan was introduced. The participants were provided with, and based discussions on, a nutritionally adequate 4-week menu that incorporated suggested foods and ingredients that were locally available, financially and physically accessible, culturally acceptable and met the serving recommendations of CFG (Health Canada, 2007). Additional information on the menu plan is available in Appendix 3 and at www.http://pureprairie.ca/. Session 3 included activities demonstrating how the menu plan could be adapted for energy needs, family size and cultural preferences, and included a cooking demonstration. In session 4 participants discussed food choices when dining out and practiced reading food labels. In session 5 participants were provided with information and had opportunity to practice carbohydrate counting and choosing carbohydrate-rich foods with a low glycemic index. In session 6, held 8 weeks after program initiation, participants toured a grocery store with a dietitian. In the week prior to the post-intervention assessment (ie. at 11 weeks), participants completed three 24-h recalls. All participants were given a $50 gift card for a grocery store of their choice for taking part in the study, and were reimbursed for parking or public transit expenses incurred. Finally, participants were invited to a post-intervention assessment 6 months after entry into the study to measure the longer-term effects of the PANDA program on biological outcomes.

3.2.4 Statistical Procedures

Baseline data are reported as mean ± SD or proportions as appropriate. Baseline differences between males and females were determined using a chi-square test for categorical variables or unpaired t-test for continuous variables with $p<0.05$ considered significant. Differences in demographic and health variables between the study completers (who provided baseline, 3 month and 6 month follow-up data) versus dropout at 3 and 6 months were analyzed by one way ANOVA (for normally distributed variables) or Kruskal Wallis test (for non-parametric variables), and the $\chi 2$ test (for nominal data).

Differences between baseline and post-intervention measures were assessed using intention-to-treat analysis conducted with 5 sets of multiple imputations (Amelia II package in R statistical software) and are reported as the mean difference between baseline and post intervention values with 95% confidence intervals (CI). Gender difference between baseline and post intervention were performed by repeated measures ANOVA. Outcomes (post-intervention A1c, change in BMI) were compared according to tertiles of baseline A1c or baseline BMI by using one-way ANOVA followed by Bonferroni post hoc test.

Pearson correlations were computed with all variables versus primary outcomes (A1c, HEI) to identify potential determinants for linear regression modeling. Variable selection in the linear regression models was based on literature review and bivariate correlation ($p<0.2$). Multiple regression analyses were used to examine the relationship between changes in BMI, HDL-C, total calories, HEI and PDAQ scores with post-intervention changes in A1c. This model was adjusted for potential confounding by age, gender, baseline BMI, and baseline A1c. Similarly, multiple linear regression was used to examine the relationship between post-intervention changes in HEI score and changes in total calories, fat intake, saturated fat intake, added sugar intake and sodium intake as well as behavioural indicators, PDAQ and DSES. This model was adjusted for age and gender. Data are reported as the change in A1c (unstandardized coefficient, B with 95% CI) predicted by a set change in the variable of interest. All regression analyses were conducted using SPSS (IBM, version 22); a p-value of <0.05 was considered statistically significant where appropriate.

3.3 Results

3.3.1 Study participants at baseline

Participants in this study were older adults and had been diagnosed with T2D for approximately 9 years. Similar numbers of men (n=39) and women (n=34) enrolled in this study (Figure 3-1; Table 3-1). Eighty-five percent of participants completed the intervention and all assessments at 3 months, and 58% of participant returned for the assessments at 6 months post intervention. Men and women in this study had similar demographic and health-related characteristics except that men had been diagnosed with diabetes for a longer period of time, scored higher than women on the Diabetes Self-Efficacy scale, and had higher systolic blood pressure.

At baseline, reported energy intake was ~2100 kcal/day. The acceptable macronutrient distribution ranges for carbohydrate and protein were met by the participants, but saturated fat (12% total energy) exceeded the recommended contribution to total energy (7%) and total fat was slightly higher than the recommended range (36% versus 35%). Added sugar (50 g/day) was also in the acceptable range (<10% of total energy) but fiber (22 g/day) was less than recommended (25 g/day) and sodium intake (3.4 g/day) exceeded the tolerable upper limit of 2.3 g/day. Generally, HEI scores indicated that participants “need improvement”, although 2 participants had poor diet quality (<51) and 8 had good diet quality (>80). HEI scores correlated significantly with PDAQ scores ($r=0.418$, $p<0.001$) (Table 3-1).

Table 3-2 Baseline characteristics of all participants

	Total cohort (n=73)	Men (n=39)	Women (n=34)	p-value*
Demographic Variables				
Age (yr ± SD)	59.2 ± 9.7	59.0 ± 10.2	59.5 ± 9.1	0.846
Ethnicity (%)				
White	87.7	84.6	91.2	0.240
Other	12.3	15.4	8.8	
Education (%)				
High school or less	15.0	15.4	14.7	0.215
More than high school	85.0	84.6	85.3	
Employment Status (%)				
Working	56.2	56.4	55.9	0.81
Other1	43.8	43.6	44.1	
Annual income (%)				
<$60,000	21.9	15.3	29.4	0.165
>$60,000	78.1	84.7	70.6	
Diabetes-Related Variables				
Duration of T2D (yr ± SD)	9.1 ± 8.3	10.8 ± 9.6	7.0 ± 5.8	0.049
Diabetes treatment (%)				
Oral medication	76.7	71.7	75.6	0.608
Other	23.3	28.3	24.4	
A1c (% ± SD)	8.0 ± 1.8	8.3 ± 1.7	7.7 ± 1.9	0.143
Diabetes Self Efficacy Scale score (maximum 10)	7.1 ± 1.5	7.5 ± 1.2	6.6 ± 1.8	0.012
Anthropometric and Physical Activity Variables				
Weight (kg ± SD)	96.4 ± 21.0	98.6 ± 20.8	93.8 ± 21.4	0.336
Body mass index (kg/m2 ± SD)	32.5 ± 6.8	31.3 ± 6.4	33.8 ± 7.1	0.117
Waist circumference (cm ± SD)	110.8 ± 16.8	112.2 ± 16.5	109.1 ± 17.2	0.336
Fat mass (kg ± SD)	40.0 ± 15.7	36.0 ± 14.4	44.6 ± 16.1	0.019
Fat mass (% ± SD)	40.4 ± 9.1	35.3 ± 7.6	46.2 ± 7.0	<0.001
Fat-free mass (kg ± SD)	56.6 ± 10.5	64.7 ± 7.6	49.3 ± 6.9	<0.001
Fat-free mass (% ± SD)	59.6 ± 9.1	64.7 ± 7.6	53.8 ± 7.0	<0.001
Physical activity (steps/day ± SD)	5535 ± 3491	6722 ± 3829	4330 ± 2375	0.002
Blood Pressure and Lipid Variables				
Systolic blood pressure (mmHg ± SD)	128.5 ± 13.5	132.5 ± 15.0	124.0 ± 10.0	0.007
Diastolic blood pressure (mmHg ± SD)	78.6 ± 8.9	80.4 ± 10.2	76.5 ± 6.7	0.066
Total cholesterol (mg/dL ± SD)	328.7 ± 82.7	326.8 ± 77.8	330.9 ± 89.1	0.833
HDL-cholesterol (mg/dL ± SD)	57.6 ± 24.5	58.6 ± 25.5	56.5 ± 23.8	0.724
LDL-cholesterol (mg/dL ± SD)	243.9 ± 80.1	241.8 ± 76.8	246.3 ± 85.1	0.812
Triglycerides (mg/dL ± SD)	135.9 ± 73.5	132.0 ± 58.9	140.4 ± 88.2	0.632
Nutrient Intake Variables				
Energy (kcal)	2109 ± 721	2161±598	2046±845	0.494

Total fat (g)	86 ± 36	87±35	84±37	0.717
Total fat (% of energy)	36 ± 7	35±7	36±6	0.430
Protein (g)	99 ± 30	103±30	94±28	0.183
Protein (% of energy)	19 ± 4	19±3	19±4	0.812
Carbohydrate (g)	238 ± 93	241±64	234±118	0.752
Carbohydrate (% of energy)	45 ± 7	45±6	45±7	0.919
Fibre (g) 2	22 ± 7	21±7	21±7	0.888
Added sugar (g)	50 ± 47	43±24	56±63	0.254
Added sugar (% of energy)	9 ± 5	8±4	9±6	0.123
Saturated fat (g)	28 ± 13	28±11	27±15	0.932
Saturated fat (% of energy)	12 ± 3	12±3	11±3	0.583
MUFA (g)	30 ± 13	29±12	30±14	0.889
MUFA (% of energy)	12 ± 3	11±3	12±3	0.105
PUFA (g)	15 ± 7	14±7	15±6	0.619
PUFA (% of energy)	6 ± 2	5±2	7±2	0.36
Sodium (g)	3.36 ± 1.56	3.57±1.50	3.11±1.60	0.217
Sodium density (mg/kcal)	1.6 ± 0.5	1.6±0.5	1.5±0.4	0.284
Diet Quality and Adherence Variables				
HEI score (maximum 100)	68.7 ± 8.9	68.1±8.1	69.3±9.8	0.533
PDAQ score (maximum 63)	32.3 ± 11.3	32.9±10.6	31.5±12.1	0.611

* Student's unpaired t-test for continuous and X^2 test for categorical variables.

[1] Unemployed or retired. [2] Dietary fiber only, does not include supplements.

The main reasons for drop out at 3 months were: lost contact (eg. no response to email or phone calls), inability to travel to meetings, loss of interest, and personal frustration. At 6 months, the majority of dropped participants were traveling during the summer, and we lost contact with other participants. Table 3-2 illustrates the differences in demographic and health variables between the completers versus dropout at 3 and 6 months. Age and baseline HEI scores were significantly higher in completers than in non-completers. The group who dropped out at 6 months had higher LDL-cholesterol at baseline.

Table 3-2 Selected baseline characteristics of participants: completers and dropouts

	Completers N=42	Drop out at 3 months N=11	Drop out at 6 months N=20	p-value[1]
Age (yr ± SD)	61.8 ± 8.3	59.0 ± 11.2	53.8 ± 9.5	0.007
Diabetes duration	9.5 ± 9.3	8.6 ± 6.1	8.2 ± 4.8	0.812
Male (n)	22	6	11	0.978
Ethnicity (white, n)	38	11	15	0.212
Education (higher than high school, n)	35	10	17	0.294
Employment (working, n)	20	7	14	0.577
A1c (% ± SD)	7.9 ± 1.8	8.4 ± 2.0	7.9 ± 1.7	0.672
Weight (kg ± SD)	95.3 ± 22.3	98.9 ± 15	97.3 ± 21.8	0.860
BMI (kg/m^2 ± SD)	32.5 ± 7.4	33.5 ± 5.8	31.9 ± 6.4	0.725
Waist circumference (cm ± SD)	109.5 ± 17.5	112.6 ± 15.4	112.5 ± 16.5	0.746
Systolic blood pressure (mm Hg ± SD)	129.3 ± 12.6	131.9 ± 12.0	125.2 ± 16.1	0.363
Diastolic blood pressure (mm Hg ± SD)	77.7 ± 8.8	80.5 ± 7.1	79.5 ± 10.1	0.576
Total cholesterol (mg/dL ± SD)	324.4 ± 81.8	334.8 ± 101.6	334.4 ± 76.9	0.876
HDL-cholesterol (mg/dL ± SD)	56.0 ± 25.3	58.5 ± 11.9	60.5 ± 28.5	0.778
LDL-cholesterol (mg/dL ± SD)	126.3 ± 59.5	114.6 ± 29.3	167.2 ± 104.3	0.006
Triglycerides (mg/dL ± SD)	243.1 ± 77.5	253.3 ± 99.5	240.4 ± 78.1	0.909
HEI score (maximum 100 ± SD)	71.4 ± 7.8	64.5 ± 9.5	65.3 ± 10.5	0.008
PDAQ score (maximum 63 ± SD)	33.9 ± 11.5	34.2 ± 10.5	28.0 ± 10.6	0.137

[1] – Differences were determined using one-way ANOVA for parametric and Kruskal Wallis test for non-parametric data (A1c and BMI).

3.3.2 Effect of PANDA–Nutrition Arm on A1c and secondary biological outcomes

Biological outcomes for the cohort are reported in Table 3-3. Three months after the initiation of the PANDA intervention, A1c had decreased by -0.7% (95% CI -1.0 to -0.4). Secondary outcomes with significant improvements included: waist circumference, BMI, fat mass (kg), fat free mass (%), systolic and diastolic blood pressure, total-C, HDL-C and LDL-C. Physical activity was also increased. At 6 months follow-up, significant reductions in A1c, waist circumference, BMI, total-C, HDL-C and LDL-C were still detected (Table 3-3). Table 3-4 illustrates differences in biological and anthropometric outcomes between genders by repeated measures ANOVA. There were no significant differences between genders except for a significant reduction in fat free mass (kg) in men but not women. The decrease in systolic blood pressure was also greater among men.

Table 3-3 Changes biological outcomes (95% CI) overall at 3 and 6 months

	3 months		6 months	
	Mean change	95% CI	Mean change	95% CI
Diabetes-related Variables				
A1c (%)	-0.7	(-1.0, -0.4)	-0.5	(-0.9, -0.1)
Diabetes Self-Efficacy Scale	0.7	(0.3, 1.0)	ND	ND
Anthropometric Variables and Physical Activity				
Weight (kg)	-1.7	(-2.2, -1.2)	-1.4	(-2.1, -0.8)
BMI (kg/m2)	-0.6	(-0.8, -0.4)	-0.5	(-0.7, -0.3)
Waist circumference (cm)	-2.4	(-3.0, -1.8)	-2.4	(-3.0, -1.8)
Fat mass (kg)	-1.2	(-2.0, -0.4)	ND	ND
Fat mass (%)	-0.8	(-1.5, 0.0)	ND	ND
Fat free mass (kg)	-0.8	(-1.8, 0.1)	ND	ND
Fat free mass (%)	0.8	(0.1, 1.6)	ND	ND
Physical activity (steps/day)	995	(368, 1623)	ND	ND
Blood Pressure and Lipids				
Systolic blood pressure (mm Hg)	-4.1	(-6.8, -1.3)	ND	ND
Diastolic blood pressure (mm Hg)	-1.7	(-3.1, -0.4)	ND	ND
Total cholesterol (mg/dL)	-63.5	(-80.1, -46.9)	-86.2	(-107.3, -65.2)
HDL-cholesterol (mg/dL)	27.5	(20.2, 34.8)	44.6	(37.2, 52.0)
LDL-cholesterol (mg/dL)	-88.9	(-105.3, -72.5)	-128.3	(-148.5, -108.2)
Triglycerides (mg/dL)	-10.4	(-23.1, 2.2)	-3.8	(-20.8, 13.2)

ND Not done

Table 3-4 Changes biological outcomes (95% CI) by gender at 3 and 6 months

	3 months			6 months		
	Men (n=39)	Women (n=34)	p-value	Men (n=39)	Women (n=34)	p-value[1]
Diabetes-related Variables						
A1c (%)	-0.9 (-1.3, -0.4)	-0.6 (-0.9, -0.2)	0.306	-0.5 (-1.1, 0.0)	-0.5 (-0.9, -0.0)	0.497
Diabetes Self-Efficacy Scale	+0.5 (0.2, 0.9)	+0.8 (0.3, 1.4)	0.334	ND	ND	
Anthropometric Variables and Physical Activity						
Weight (kg)	-1.8 (-2.6, -0.9)	-1.6 (-2.1, -1.1)	0.78	-1.8 (-2.6, -1.1)	-1.0 (-2.0, 0.1)	0.346
BMI (kg/m2)	-0.6 (-0.9, -0.3)	-0.6 (-0.8, -0.4)	0.967	-0.6 (-0.8, -0.3)	-0.3 (-0.7, 0.0)	0.399
Waist circumference (cm)	-2.8 (-3.7, -1.9)	-2.0 (-2.8, -1.1)	0.185	-3.1 (-3.8, -2.4)	-1.7 (-2.8, -0.6)	0.08
Fat mass (kg)	-0.7 (-2.0, 0.6)	-1.7 (-2.7, -0.7)	0.219	ND	ND	
Fat mass (%)	-0.8 (-1.5, 0.0)	-0.7 (-2.2, 0.7)	0.984	ND	ND	
Fat free mass (kg)	-1.7 (-3.2, -0.2)	0.1 (-0.7, 1.0)	0.042	ND	ND	
Fat free mass (%)	0.9 (0.1, 1.7)	0.8 (-0.7, 2.3)	0.912	ND	ND	
Physical activity (steps/day)	1062 (124, 2000)	919 (56, 1781)	0.822	ND	ND	
Blood pressure and lipid profile						
Systolic blood pressure (mm Hg)	-6.6 (-10.3, -2.9)	-1.2 (-5.1, 2.8)	0.047	ND	ND	
Diastolic blood pressure (mm Hg)	-2.9 (-4.8, -1.0)	-0.4 (-2.3, 1.5)	0.064	ND	ND	
Total cholesterol (mg/dL)	-69.9 (-93.7, -46.1)	-56.1 (-80.1, -32.2)	0.414	-78.4 (-110.3, -46.5)	-95.2 (-123.2, -67.3)	0.218
HDL-cholesterol (mg/dL)	23.5 (13.3, 33.7)	32.1 (21.5, 42.7)	0.243	43.9 (32.9, 54.9)	45.4 (35.0, 55.8)	0.431

LDL-cholesterol (mg/dL)	-91.5 (-115.4, -67.6)	-85.9 (-109.2, -62.6)	0.735	-120.4 (-150.0, -90.8)	-137.4 (-165.5, -109.2)	0.358
Triglycerides (mg/dL)	-9.3 (-25.4, 6.8)	-11.7 (-32.6, 9.2)	0.851	-1.9 (-26.4, 22.6)	-5.9 (-30.6, 18.7)	0.944

[1] p-value= gender difference in the time period indicated

3.3.3 Effect of PANDA – Nutrition Arm on dietary adherence and diet quality at 3 months

Changes in dietary adherence were measured by comparing pre- and post-intervention, averaged 24-h dietary recall data (Table 3-5). There were post-intervention reductions in intakes of total energy, and total fat, protein, added sugar, saturated fat, sodium, and sodium density (mg sodium/1000 kcal). Macronutrient distribution did not change significantly except PUFA. HEI improved by +2.1 points (95% CI 0.2 to 4.1). There was a significant positive shift in the number of participants in a higher HEI category after the intervention (X^2 (N=73) =29.31, p<0.001). Seven participants whose diet quality was categorized as “needs improvement” prior to the intervention improved to “good” diet quality. The total fruit and whole fruit components scores were significantly increased, whereas total grain was significantly decreased. On the other hand, saturated fat and sodium components scores were increased, indicating lower consumption. After 3 months, PDAQ score significantly increased by 8.4 points as did the score on the Diabetes Self-Efficacy scale by +0.7 (Table 3-5). Table 3-6 presents changes in dietary adherence by gender comparing pre- and post- intervention. No gender difference was observed in dietary changes, diet quality, and Perceived Dietary Adherence Questionnaire scores.

Table 3-5 Changes in reported nutrient and food group, diet quality, and Perceived Dietary adherence questionnaire (95% CI) at 3 months

Variables	Mean change	95% CI
Nutrients		
Energy (kcal)	-178	(-304, -51)**
Total Fat (g)	-10.2	(-17.6, -2.7)**
Total Fat (%)	-1.1	(-2.5, 0.4)
Protein (g)	-5.8	(-11.1, -0.4)*
Protein (%)	0.4	(-0.4, 1.3)
Carbohydrate (g)	-11.8	(-27, 3.5)
Carbohydrate (%)	1.9	(-0.2, 3.7)
Fibre (g)	0.0	(1.3, 0.0)
Added sugar (g)	-8.5	(-16, -2.1)*
Added sugar (%)	-0.3	(-1.4, 0.8)
Saturated fat (g)	-3.5	(-6.3, -0.6)*
Saturated fat (%)	-0.4	(-1.2, 0.4)
MUFA (g)	-2.7	(-5.6, 2)
MUFA (%)	0.1	(-0.7, 1.0)
PUFA (g)	0.1	(-1.6, 1.8)
PUFA (%)	0.8	(0.1, 1.4)*
Sodium (g)	-0.57	(-0.87, -0.28)***
Sodium density (mg/ kcal)	-0.14	(-0.26, -0.03)*
Diet quality and adherence		
Health Eating Index score (maximum 100)	2.1	(0.1, 4.1)*
Total fruits and vegetables (maximum 10)	0.5	(0.1, 0.9)*
Whole fruits (maximum 5)	0.4	(0.1, 0.7)*
Dark green/orange vegetables (maximum 5)	-0.1	(-0.4, 0.3)
Total grains (maximum 5)	-0.3	(-.06, -0.2)*
Whole grains (maximum 5)	0.3	(-0.1, 0.7)
Dairy (maximum 10)	-0.2	(-0.6, 0.3)
Meat/beans (maximum 10)	0.2	(-0.3, 0.6)
Unsaturated fat (maximum 10)	-0.1	(-0.6, 0.4)
Saturated fat (maximum 10)	0.9	(0.1, 1.7)*
Sodium (maximum 10)	1.1	(0.4, 1.7)**
Other (maximum 20) [1]	-0.1	(-1.3,1.1)
Perceived dietary adherence score (maximum 63)	8.5	(6.1, 10.8)***

[1]Calories from solid fats, alcohol and added sugars, a higher score indicates lower consumption
* $p < 0.05$; ** $p < 0.001$; *** $p < 0.0001$.

Table 3-6 Changes in reported nutrient and food group, diet quality, and Perceived Dietary adherence questionnaire (95% CI) at 3 months by gender

Variable	Men (n=39)	Women (n=34)	p-value
Nutrients			
Energy (kcal)	-179.4 (-367.0, 8.3)	-176.0 (-353.3, 1.3)	0.979
Total Fat (g)	-9.3 (-21.4, 2.8)	-11.3 (-20.7, -2.0)	0.791
Protein (g)	-6.4 (-13.4, 0.7)	-5.1 (-13.6, 3.5)	0.809
Carbohydrate (g)	-4.9 (-24.7, 14.8)	-19.7 (-45.6, 6.1)	0.352
Fibre (g)	0.5 (-1.5, 2.4)	-0.5 (-2.2, 1.2)	0.462
Added sugar (g)	-4.7 (-12.4, 2.9)	-12.9 (-28.8, 3.0)	0.329
Saturated fat (g)	-2.9 (-7.1, 1.3)	-4.1 (-8.1, -0.1)	0.678
MUFA (g)	-1.0 (-5.5, 3.4)	-4.6 (-8.4, -0.7)	0.236
PUFA (g)	0.2 (-2.4, 2.9)	0.0 (-2.3, 2.2)	0.883
Sodium (g)	-0.65 (-1.11, -0.18)	-0.49 (-0.86, -0.11)	0.593
Sodium density (mg/kcal)	-0.16 (-0.35, 0.02)	-0.12 (-0.27, 0.02)	0.753
Diet quality and adherence			
Health Eating Index	1.4 (-1.6, 4.4)	3.0 (0.3, 5.6)	0.434
Perceived dietary adherence score	7.8 (4.6, 10.9)	9.3 (5.4, 12.9)	0.522

When participants were sorted by baseline A1c into tertiles, there were no differences in impact of the intervention on BMI, blood pressure, lipid profile, and nutrition outcomes, except A1c. The post hoc test revealed that Tertile 3 experienced a significantly greater improvement in A1c than Tertiles 1 or 2 after 3 months (Table 3-7). A similar analysis was performed after stratifying the participants by baseline BMI. There were no differences in the magnitude of change of BMI, blood pressure, lipid profile, and nutrition outcomes, except PDAQ score. However, when the post hoc test was performed, no specific significant differences between tertiles were detected (Table 3-8).

Table 3-7 Changes in biological and nutrition outcomes (means ± SD) at 3 months, comparing tertiles of baseline A1c

Variables – Change after 3 months	1st Tertile 5.5-6.9% n=24	2nd Tertile 7.0-8.3% n=24	3rd Tertile 8.4-14.0% n=25	p- value
A1c (%)	-0.2 ± 0.4	-0.3 ± 0.6	-1.6 ± 1.7*	0.000
BMI (kg/m^2)	-1.9 ± 3.0	-2.0 ± 2.0	-1.5 ± 1.7	0.690
Systolic blood pressure (mm Hg)	-2.2 ± 11.2	-1.9 ± 7.3	-4.0 ± 7.7	0.664
Diastolic blood pressure (mm Hg)	-1.5 ± 7.1	-2.6 ± 8	-1.1 ± 6.3	0.753
Total cholesterol (mg/dL)	-17.2 ± 18.1	-14.5 ± 13.2	-18.8 ± 21.3	0.705
HDL-cholesterol (mg/dL)	53.7 ± 73.2	86.8 ± 96.2	100.9 ± 112.9	0.217
LDL-cholesterol (mg/dL)	-24.3 ± 49.2	-30.4 ± 16.3	-37.3 ± 23.4	0.386
Triglycerides (mg/dL)	-0.3 ± 37.3	-2.0 ± 26.4	-4.5 ± 42.5	0.919
HEI score (score)	4.3 ± 10.6	1.4 ± 12.4	5.1 ± 14.6	0.569
PDAQ score (score)	7.1±10.2	9.7 ±11.2	8.7±8.6	0.672

P-value (One-Way ANOVA)
* Tertile 3 is significantly different from both Tertile 1 and Tertile 2 by Bonferroni post-hoc test.

Table 3-8 Changes in biological and nutrition outcomes (means ± SD) at 3 months, comparing tertiles of baseline BMI

Variables – change after 3 months	1st Tertile 22.1-28.6 kg/m^2 n=24	2nd Terile 28.8-34.1 kg/m^2 n=25	3rd Tertile 34.2-51.6 kg/m^2 n=24	p-value[1]
A1c (%)	-1.0 ± 1.5	-0.7 ± 0.9	-0.5 ± 1.2	0.325
BMI (kg/m^2)	-2.1 ± 2.0	-1.7 ± 2.8	-1.5 ± 2	0.649
Systolic blood pressure (mm Hg)	-3.2 ± 5.6	-4.4 ± 10.2	-0.5 ± 9.7	0.278
Diastolic blood pressure (mm Hg)	-2.3 ± 5.9	-2.9 ± 7.2	0.1 ± 7.8	0.228
Total cholesterol (mg/dL)	-18.3 ± 14.3	-15.3 ± 19.2	-16.9 ± 19.8	0.848
HDL-cholesterol (mg/dL)	99.2 ± 131.2	78.5 ± 80.7	64.6 ± 67.3	0.465
LDL-cholesterol (mg/dL)	-34.2 ± 17.3	-30.1 ± 20.6	-27.9 ± 50.9	0.804
Triglycerides (mg/dL)	-3.4 ± 33.9	1.4 ± 57	-5.1 ± 24.9	0.807
HEI score (maximum 100)	7.0 ± 8.7	1.3 ± 13.9	2.6 ± 14.3	0.256
PDAQ score (maximum 63)	6.3 ± 10.6	6.6 ± 8.7	12.7 ± 9.7	0.041

[1] One-Way ANOVA. No specific differences were detected using Bonferroni post-hoc test

3.3.4 Predictors of changes in A1c and HEI score

Multiple linear regression analysis was carried out to examine the relationship between relative changes in the primary outcome (change in A1c) and changes in nutritional variables (total calories and HEI), biological variables (BMI, HDL-C) and physical activity at 3 months (Table 3-9). In the unadjusted model (Model 1), an increase in HDL-C and physical activity predicted reductions in A1c. In Model 2, adjusting for baseline A1c, baseline BMI, age and gender somewhat attenuated HDL-C as a predictor of reductions in A1c and physical activity became non-significant. However, the adjustments strengthened the relationship of BMI with reduced A1c. In both models, change in HEI score was not significant ($p<0.1$). To examine influences on changes in HEI score, multiple linear regression was carried out including nutritional changes identified in Appendix 4 as predictors. In both unadjusted (B=-0.111 (95% CI -0.186, -0.035)) and adjusted models (B=-0.117 (95% CI -0.195, -0.039)), a decrease in saturated fat intake was the only significant variable associated with increased HEI. Neither changes in PDAQ or DSES score were associated with change in HEI in simple linear regressions and so were not included in the model.

Table 3-9 Unadjusted and adjusted multiple linear regressions examining variables as predictors of A1c change after the PANDA intervention

	Variables	Change in A1c (%) per unit change in variable of interest	95% CI
Model 1*	Increase in PA (100 Steps)	-0.002	-0.04 to 0.00
	Increase in HDL-C (10 mg/dL)	-0.054	-0.081 to -0.027
	Increase in HEI (1 unit)	-0.018	-0.038 to 0.001
	Decrease in BMI (1 kg/m^2)	-0.081	-0.030 to 0.019
	Decrease in total calories (10 kcal)	0.070	-0.040 to 0.180
Model 2**	Increase in PA (100 Steps)	0.000	-0.002 to 0.001
	Increase in HDL (10 mg/dL)	-0.022	-0.041 to 0.001
	Increase in HEI (1 unit)	-0.012	-0.027 to 0.002
	Decrease in BMI (1 kg/m^2)	-0.113	-0.033 to -0.194
	Decrease in total calories (10 kcal)	0.040	-0.040 to 0.110

Variables shown in bold text are significant predictors ($p<0.05$).
* unadjusted
** adjusted for age, gender, baseline A1c, and baseline BMI

3.4 Conclusion

The results of this study indicate that the PANDA Nutrition Arm effectively improved clinical outcomes and dietary adherence in type 2 diabetic patients. The menu plan was based on the 4-A Framework for content and the intervention utilized Social Cognitive Theory for process. Significant improvements were found across anthropometric variables, lipid profile variables and A1c after 3 months and sustained at 6 months. Effectiveness and sustainability of the menu plan program to improve clinical outcomes occurred despite the fact that the intervention focussed on nutrition education and healthy eating patterns, not weight loss.

We observed important changes in participants´ eating patterns following the PANDA program. The pattern of macronutrient intake (as % total energy) did not change although the total calories were reduced by 8%. Diet quality (HEI score) improved modestly after 3 months. The improvement in the total HEI scores was largely driven by greater total fruit and whole fruit sub-scores, and lower saturated fat and sodium sub-scores. However, participants classified as having good diet quality (HEI > 80) increased from 11% to 20% of the cohort at 3 months. The improved total score was attributable to increased whole fruit intake along with decreased saturated fat and sodium sub-scores. The importance of saturated fat to this result was reiterated in the multiple linear regression analysis. These results are in line with our pilot study outcomes, in which energy intake was reduced by 20% although the mean HEI score did not change. A meta-analysis of 15 cohort studies reported that diet quality was associated with reduced risk of all-cause mortality, CVD, cancer and type 2 diabetes (Schwingshackl & Hoffmann, 2015). Therefore, improvement of diet quality may have positive consequences in the risk of further complications for people with type 2 diabetes.

The biggest change in diet was a reduction in sodium intake that persisted after adjusting for energy intake. This improved sodium consumption pattern may reflect changes in eating habits of study participants, for example eating more food cooked from scratch versus restaurant meals (Wang et al., 2013). A study of the DASH diet showed that limiting sodium intake to <2300 mg/d predicted reduced blood pressure (systolic/diastolic) by 16.1/9.9 mm Hg (DASH plus weight management); 11.2/7.5 mm Hg (DASH alone); and 3.4/3.8 mm Hg (usual diet controls) (Blumenthal et al., 2010). Our study showed a significant reduction in systolic blood pressure by 4.1 mm Hg, and diastolic blood pressure by 1.7 mm Hg, which is similar to other studies. Aburto et al, 2013 systematic review and meta-analysis. A systemic review investigated the benefit of decreased sodium intake on blood pressure and CVD risk. Systolic blood pressure was reduced by 3.4 mm Hg and diastolic blood pressure by 1.8 mm Hg when sodium intake was <2 g/day versus ≥2 g/day. Increased sodium intake was associated with an increased risk of stroke (Odds ratio 1.24, 95% CI 1.08 to 1.43), stroke mortality (1.63, 95% CI 1.27 to 2.10), and coronary heart disease mortality (1.32, 95% CI 1.13 to 1.53) (Aburto et al., 2013). A 24-week meal preparation intervention was conducted in T2D patients. The program successfully reduced weight, A1c, and there was a trend toward lower blood pressure but sodium intake was not documented (Dasgupta et al., 2012). We were not able to confirm the association between changes in sodium intake and blood pressure, probably because the study was not powered to detect this and because mean sodium intake remained above 2300 mg/d. Therefore, the PANDA intervention menu plan leading to overall improved diet quality or physical activities may potentially lead to improved blood pressure control.

Adherence to the Canadian nutrition recommendations for diabetes was assessed by the PDAQ. This questionnaire was developed to ask about adherence to CDA nutrition therapy recommendations (Dworatzek et al., 2013) and has adequate correlation coefficients versus 24-h recalls and acceptable intra-class correlation (0.78) (Asaad et al., 2015). We found a significant improvement in the PDAQ score after 3 months (+8.5 points), which implies that the PANDA

Nutrition Arm is feasible for helping people with diabetes to follow the dietary recommendations, and possibly more sensitive to behavioural change than assessment of dietary intake because it asked specific questions about fiber and glycemic index, for example. Self-efficacy of patients also increased as a result of knowledge gained during the intervention. The low attrition rate observed, 15% after 3 months reflected acceptability of the menu plan approach among participants.

The PANDA Nutrition Arm led to a significant improvement in A1c at 3 months (-0.7%) that was sustained 6 months after the program. Higher baseline A1c levels were associated with greater declines in A1c after 3 months. This change in A1c is greater than found in several other nutrition interventions including Bader et al., 2013 (−0.4%, 95% CI −0.6 to −0.2), Dasgupta et al., 2015 (-0.3%, 95% CI -0.6 to -0.1) and Chen et al., 2015 systematic review and meta-analysis of 16 studies (-0.37%, 95% CI, -0.59 to -0.14) in adults with type 2 diabetes. A systematic review (Chrvala, Sherr &Lipman 2015) of the effect diabetes self-management education on glycemic control in adults with type 2 diabetes in 120 studies reported an overall mean reduction in A1c of 0.74% and 0.17% for intervention and control groups, respectively. The mean change in A1c of 33 studies that used group education methods was 0.6% and 0.2% for the intervention and control groups, respectively. Out of 33 studies, 22 studies had a significant decrease in A1c with a range of -0.2 to -2.3%. Our A1c change (-0.7%) is considered clinically relevant and, if sustained can reduce the risk of long-term diabetes complications (The Diabetes Control and Complications Trial Research Group, 1993; UK Prospective Diabetes Study Group, 1998).

Weight loss was the strongest predictor of improved A1c, with -1 kg/m^2 predicting a 0.1% reduction in A1c. Our results are consistent with the Look AHEAD cohort, which showed that a modest weight loss of 2-5% was associated with significant improvement in A1c (1.80%

[95% CI 1.44–2.24]), and other CVD risk factors (Wing et al., 2011). We also observed significant changes in fat mass and waist circumference similar in magnitude to those observed in the Look AHEAD trial (Gallagher et al., 2014). The inverse relationship between changes in A1c and serum HDL-C shown in the PANDA intervention has been reported by others (Ahmad Khan, 2007; Gatti et al., 2009) but is not as well established as that between A1c and BMI and is not seen in all studies (Lee, Yim, Kim, & Choue, 2014; Waldman et al., 2014). However, a prospective trial demonstrated that low baseline HDL-C predicted more rapid long-term progression of T2D (Waldman et al., 2014). HDL-C promotes insulin secretion and protection from apoptosis of beta-cells (Rütti et al., 2009), which may be related to HDL-C-mediated anti-oxidative and cellular cholesterol efflux activities (Dullaart, Annema, de Boer, & Tietge, 2012). HDL-C also improves insulin-independent glucose uptake into skeletal muscle (Drew et al., 2009). Thus, some authors recommend that increasing HDL-C be considered an important strategy to improve glycemic control (Waldman, Jenkins, Sullivan, Ng, & Keech, 2015). Improved diet quality (HEI) had a borderline association with reduced A1c ($p<0.1$), which may serve to emphasize the difficulty in documenting relevant dietary changes.

Cardiovascular disease (CVD) is the leading cause of death among diabetic patients. Lifestyle interventions have the potential to improve several risk factors for CVD such as glycemic control, blood pressure and lipids (Dworatzek et al., 2013; Maahs et al., 2014; Soria-Contreras et al., 2014). After the PANDA program, we observed improvements in total-C, HDL-C and LDL-C at 3 and 6 months. Moreover, consistent with similar studies (Soria-Contreras et al., 2014), a significant reduction in blood pressure was found. The significant changes in clinical outcomes documented after the PANDA intervention, if sustained over the long-term, may lower risk of future CVD.

One major difference between the PANDA nutrition intervention and other similar programs is our emphasis on the 4-A Framework. We propose that focusing on the 4-A Framework for the diabetes menu plan for management achieved the desired effect. Providing locally grown or imported ingredients (Food Availability) may have increased feasibility for the participants to adopt the menu plan. Most recipes used affordable ingredients (Food Accessibility, Bell R.C. and Chan. C.B., unpublished data) to help overcome the barrier related to food prices. The menu plan was based on culturally acceptable food for diabetic Albertan participants (Acceptable Food) and it was clear and easy to follow. Diet acceptability was measured by food acceptability questionnaire pre- and post-intervention. Prior to PANDA, a significant positive association existed between HEI and diet acceptability scores ($r=0.407$, $p<0.006$). The diet acceptability score increased significantly ($p<0.05$) from 18.7±4.4 to 21.7±4.1 (maximum 29). The results suggest that that more acceptable diets could improve diet quality and health outcomes (Asaad et al., 2013). The recipes also tasted good; participants particularly commented on the idea of flavoring foods with spices, and enjoyed the variety of food. One participant said: "I'm really happy that- there are so many things that I can eat, you know, that I didn't, I wasn't aware of, because the big fear of sugar, sugar, sugar" (Diana Soria Contreras, unpublished data). Thus, the 4-A Framework underpinning the PANDA menu plan helped to ensure adequate nutrient intake (Food adequacy), and improve diet adherence and health outcomes among individuals with T2D. As part of the evaluation of the intervention, participants also completed pre- and post-intervention questionnaires regarding food availability and accessibility. These data have not yet been analysed, but we anticipate that information contained therein will support the importance of the 4-A Framework in determining the observed outcomes on diet quality and blood glucose control.

A strength of this study is that we translated the complex CDA nutrition recommendations, and the serving recommendations suggested in CFG into a simple and practical menu plan, around which the theory-based education program was built. The menu plan also took into consideration food environment factors such as availability, accessibility, and acceptability. Several outcomes including A1c, anthropometric measurements, and lipid profile were measured at the end of the intervention and 3 months after the final contact. We were able to compare these biological outcomes to nutritional changes using a web-based 24-h recall platform that participants readily used. The study used several strategies to increase retention rate, including reimbursement for parking or public transit expenses and a gift card for $50 of groceries for participating. Telephone and email reminders were also helpful. There are several limitations of this study. First, the study did not include a control group and participants were self-selected volunteers, which may affect overall motivation. The majority of the participants were Caucasian; therefore, we cannot generalize the results to all ethnicities. Even though dietary intakes were assessed with a validated internet-based questionnaire, measurement error may occur due to inaccurate reporting by participants. Also, the platform could not distinguish between home-cooked or restaurant meals, such details as types of oil in salad dressings or homemade vs canned soup, which may therefore under-estimate shifts in consumption patterns. Therefore, changes in biological variables may more accurately reflect the effectiveness of the program than analysis of dietary intake. In addition, the study did not assess dietary adherence in the follow-up assessment.

In summary, the menu plan delivered as part of an education program led to significant improvements in glycemic control, lipid profile, and anthropometric measurements that were sustained over 6 months. Also, positive changes in dietary habits, including reduced sodium intake were documented. The PANDA Nutrition Arm was shown to be effective and feasible for improving clinical outcomes in diabetic patients. Further research is warranted to examine its delivery in a community-based model.

Chapter 4. Food sources of sodium, saturated fat and added sugar in the Physical Activity and Nutrition for Diabetes in Alberta (PANDA) Trial

4.1 Introduction

Diabetes is a challenging disease to monitor and manage, requiring patients to self-monitor blood glucose, take their medications, and implement dietary modification and exercise (Dworatzek et al., 2013). Non adherence to dietary recommendations is an issue that has been extensively documented (Asaad et al., 2015; Coyle, Francis, & Chapman, 2013; Eilat-Adar et al., 2008; Muñoz-Pareja et al., 2012; Rivellese et al., 2008; Thanopoulou et al., 2004). The factors contributing to therapeutic non-compliance in several disease states have recently been reviewed and include factors related to the patient, type of therapy, socioeconomic status, the healthcare system, and disease severity (Jin, Sklar, Min Sen Oh, & Chuen Li, 2008). Nutrition therapy is crucial for successful diabetes management. Making changes in dietary pattern of diabetic patients leads to improvements in glycated hemoglobin (A1C) of 1.0-2.0%, serum cholesterol levels, and weight management (Dworatzek et al., 2013). On the other hand, poor glycemic control is associated with macrovascular and microvascular complications in diabetic patients (Stratton et al., 2000).

Evidence links food and dietary patterns to the risk of developing type 2 diabetes. Sugar (Janket, Manson, Sesso, Buring, & Liu, 2003) and fat intake (Ericson et al., 2015), and unhealthy/western pattern characterized by high intakes of refined carbohydrate, processed meat, and fried food (McEvoy et al., 2014) are associated with increased risk of type 2 diabetes. Individual nutrients and diet patterns also play a role in diabetes management. Sucrose intake more than 10% of daily total energy may increase blood glucose and triglycerides in people with type 2 diabetes (Dworatzek et al., 2013). Saturated fats should be restricted to less than 7% of total daily energy due to the high risk of coronary artery disease in people with type 2 diabetes (Dworatzek et al., 2013). There is no specific recommendation for sodium intake according to the Canadian Diabetes Association (Dworatzek et al., 2013), but the Dietary Approaches to Stop Hypertension trial has shown that moderate daily sodium intake (<2400 mg) decreased systolic and diastolic blood pressure, as well as decreasing A1C, and had beneficial effects on cardiometabolic risks (Azadbakht et al., 2011). The tolerable upper intake limit (UL) for adults in Canada is 2300 mg/day (Health Canada, 2012a). Health Canada provides longitudinal data on food and nutrient consumption for the Canadian population (Health Canada, 2007). Identifying common food sources of nutrients in the diet of the general population is valuable because it is offers experts the ability to determine potential benefits to improving diet quality, promote health and prevent disease (National Academy, 1988). Such an exercise in a diabetic population is also beneficial to identify and focus intervention efforts on unhealthy diet pattern and foods in order to improve glycemic control and health outcomes. Certain approaches to improve dietary patterns may lend themselves to reducing processed foods, which are typically high in sodium, fat or sugar. For example, menu planning may assist people with diabetes to identify and adhere to healthy eating patterns while provision of simple recipes may also be of benefit because studies of other populations have shown that home-cooking improves diet quality (Wolfson & Bleich, 2015).

Research in Spain identified the sources of food that contributed most to sodium, saturated fat and added sugar in people with chronic diseases including type 2 diabetes (Guallar-Castillón, Muñoz-Pareja, Aguilera, León-Muñoz, & Rodríguez-Artalejo, 2013). To our knowledge, no previous studies have analyzed food sources of sodium, saturated fat, and added sugar or the impact of a dietary intervention on those foods in Canadian adults with diabetes. The Physical Activity and Nutrition for Diabetes in Alberta (PANDA) trial focuses on healthy eating with provision of menu plans and recipes as primary education tools. We previously showed that 12-week implementation of the PANDA intervention reduced A1c by 0.7%, and had beneficial effects on cholesterol and blood pressure. Participants had reduced intake of calories, added sugar and sodium but saturated fat consumption was stable (Chan, Asaad, Contreras, Mccargar, & Bell, 2014). The aim of this secondary analysis was to identify primary food sources of sodium, saturated fat, and added sugar at baseline and how each was changed by participation in the PANDA intervention study after 3 months. We hypothesized that intakes of these nutrients from processed foods would be reduced after the intervention.

4.2 Methods

4.2.1 Study sample and intervention

The PANDA study was a single-arm nutrition intervention (ClinicalTrials.gov registration NCT01625507). The primary outcomes were dietary adherence to recommendations and hemoglobin A1c. Details of the study design, participant recruitment and primary outcomes are reported elsewhere (Chapter 3). We included participants between 35-80 years of age, who had been diagnosed with type 2 diabetes (self-report), were able to read and communicate in English, and attend meetings at the study site. Potential participants were screened by phone by the study coordinator to exclude those with concomitant diseases or conditions would preclude following the menu plan, type 1 diabetes, severe diabetes complications or pregnancy. Sample size was calculated to detect a clinically relevant, 0.5% change in hemoglobin A1c concentration (alpha=0.05, beta=0.8, paired t-test) and to account for a drop-out rate of 30% based on a pilot study (Soria-Contreras, Bell, McCargar, & Chan, 2014). At baseline, participants completed a series of demographic and diabetes care-related questionnaires, anthropometric measures, and had blood sampled for A1c and lipid analyses.

Details of the PANDA dietary intervention were presented elsewhere (Asaad et al, submitted). The 3-month intervention was delivered by a dietitian to 5 small groups (12-14/group) of participants who received a 4-week menu plan with recipes (Chan et al., 2014) and 6 education sessions focused on healthy eating strategies. The menus were constructed so that saturated fat constituted 7% or less of total energy and average sodium was <2800 mg/day. The amount of added sugar was not calculated at the time of menu plan development; however, the menus were designed to be relatively low in added sugar.

4.2.2 Dietary assessment

Changes in dietary intake over the intervention period were measured by 3 repeated 24-hour dietary recalls (collected on 2 weekdays and 1 weekend day) using WebSpan, an internet-based questionnaire, completed by participants at baseline and 3-months. WebSpan utilization has been shown to reduce assessment error and bias (Storey & McCargar, 2012). Dietary data were checked for accuracy by a trained graduate student. Duplicate entries of a single food item were removed. The WebSpan database utilizes the Canadian Nutrient File database (2001, Health Canada, Ottawa, ON, Canada) to generate sodium and saturated fat values of foods, corrected for portion size. The WebSpan software does not calculate added sugar. Added sugar (fructose plus sucrose) was calculated manually from a database developed by us for commonly consumed Canadian foods (Bell, R. C. et al; unpublished data). To determine the contribution of food sources to sodium, saturated fat, and added sugar intake, all foods were classified into groups based on relatively homogenous composition (Table 4-1) adapted from Guallar-Castillón et al. (2013). The contribution that specific categories made to the percentage of total sodium, saturated fat and added sugar daily intake was calculated. Daily consumption from each category was represented as a percentage of total daily intake. Participants were excluded from the analysis if they did not complete the three 24-hour dietary recalls pre- and post-intervention or reported consumption of implausible total energy values (outside the range of 500-3500 kcal/d for women and 800-4000 kcal/d for men) (Willett, 1998). Among 73 participants, n=61 were included in the analysis, and no subjects were excluded for implausible energy intake.

Table 4-1 Food classification for food sources

Code	Food group	Components
1	Bread	Bread/ bagels/ buns
2	Breakfast cereals	Wheat cereal/corn cereal/rice cereal/oatmeal
3	Breakfast pastries	Muffins/cinnamon buns/waffles/pancakes/granola bars
4	Pasta/rice/grains	Pasta/noodles/rice/quinoa/couscous
5	Grain snacks	Crackers/pretzels
6	Milk	1-4% fat milk
7	Non-fat milk & alternatives	Skim milk/rice milk/soy milk
8	Chocolate milk	2% chocolate milk/1% chocolate milk
9	Dairy desserts/ yogurt	Yogurt/ice cream/smoothies/pudding/sour cream
10	Cheese	Fresh cheese/cured cheese/cheese spread
11	Processed meat	Sausage/luncheon meat/ham
12	Fish	Fresh fish/canned fish
13	Seafood	Crustaceans/molluscs
14	White meat	Poultry
15	Eggs	
16	Red meat	Veal/beef/pork/lamb
17	Meat alternatives	Nuts/dried beans/lentils
18	Fruits & vegetables	Fresh/dried
19	Vegetables juices	Vegetables /tomato juice
20	Sweetened fruits	Sweetened fruit juices, Canned fruits
21	Fruit juices	Unsweetened fruit juices
22	Condiments	Ketchup/mustard/mayonnaise/pickles/relish/gravy/salsa
23	Asian sauces	Soy sauce/Teriyaki sauce
24	Soft drinks	Sugar-sweetened pops/energy drinks
25	Liquor	Beer/wine
26	Sugar/honey/syrup	White sugar/brown sugar/maple syrup/pancake syrup
27	Jam/jelly	Fruit jam/fruit jelly
28	Baked goods/desserts	Cookies/cake/ brownies/pies
29	Chocolate	Chocolate bars/chocolate spread/fudge
30	Candy	Hard candy/sugary chewing gum/ licorice candy
31	Dressing/ dip	Salad dressing/ hummus
32	Fats and oils	Oils/butter/margarine
33	Chips	Cheesies/potato chips/tortilla chips
34	Fast food	Beef and chicken hamburgers/hotdogs/French fries/onion rings/chicken fingers
35	Pizza	
36	Sandwiches & wraps	
37	Soups	
38	Mixed food meat based	Meat pies/stir fries/stews
39	Mixed food grain based	Sushi/fried rice/perogies/pasta dishes/nachos with toppings
40	Mixed food vegetable based	Vegetarian chilis and stir fries

4.2.3 Statistical analysis

The contribution that specific categories of food made to the daily percentage intake of total sodium, saturated fat, and added sugar was calculated as *(nutrient content of the food classification (Table 1) summed for all individuals/total daily intake of target nutrient from all foods for all individuals)*100%* (Guallar-Castillón et al., 2013). Gender differences in total intakes were compared by unpaired t-test. To evaluate the effectiveness of the intervention, a paired t-test was used to compare the change in food sources of sodium, saturated fat, and added sugar pre- and post-intervention. Chi-squared tests were used to explore the differences in the number of participants who met nutrition recommendations pre- and post-intervention. Analysis were performed using IBM SPSS version 22 (SPSS Inc., Chicago, IL, USA), and statistical significance was determined at $p<0.05$. Because the study was not initially powered to detect changes in food sources, trends in consumption were also noted if $p<0.1$.

4.3 Results

The 61 participants included in food source analyses included 32 males and 29 females, with an average age of 59.2±9.5 years, duration of diabetes of 9.3±8.6 years and the majority were Caucasian (85.2%). Baseline A1c was 7.9±1.7%, BMI 32.4±7.0 kg/m^2, systolic blood pressure 128±14 mmHg, and diastolic blood pressure 78±9 mmHg.

At baseline, average daily sodium and saturated fat intakes exceeded recommendations, whereas added sugar intakes met the recommendation (Table 4-2). After the intervention there was a significant ($p<0.01$) reduction in daily sodium intake and sodium density with trends ($p<0.1$) to reduced saturated fat and added sugar intakes (Table 4-2).

Table 4-2 Average of sodium, saturated fat and added sugar in the PANDA intervention (N=61)

Nutrients	Pre-intervention	Post-intervention	p-value	Recommendation
Sodium (mg/ day)	3281±1348	2720±973	0.001	<2300 mg/day a
Sodium density (sodium mg /1000 kcal)	1.6±0.5	1.4±0.3	0.006	
Saturated fat (g/day)	26.8±11.1	23.9±10.8	0.058	
Saturated fat (% TE)	11.4±2.7	10.8±3.1	0.154	<7% TE b
Added sugar (g/day)	47.1±38	40.1±24.2	0.097	
Added sugar (%TE)	8.7±4.8	8.3±4.0	0.492	<10% TE b

a- Health Canada upper daily limit (Health Canada, 2007)
b - Canadian Diabetes Association clinical practice guidelines 2013 (Dworatzek et al., 2013)

Table 4-3 displays the primary food sources of sodium before and after the PANDA intervention. Bread was the major source of sodium for diabetic participants. Other important sources of sodium included processed foods (luncheon meats, soups, condiments) and grain based mixed foods such as pasta dishes. The total contribution of sodium from these sources was >40% of intake (about 1300 mg/day). On average, a significant reduction in sodium intake (-561 mg, 95% CI -891, -230) was achieved after 3 months. The main food sources contributing to the reduction included decreased consumption of processed foods ($p < 0.05$) with a trend to reduced bread consumption ($p < 0.1$). The reduction in sodium from processed foods amounted to 467 mg/day, or >80% of the total reduction in sodium. Table 4-4 illustrates the correlations between changes in primary food sources of sodium and reduction in sodium intake. Reductions in bread, processed meats, soup, and condiments consumption were correlated with reduction in sodium intake.

Table 4-3 Effect of the PANDA intervention on intake of sodium from the top five food sources

Food sources of sodium	Contribution at baseline (% of total)	Pre-intervention (mg/day)	Post-intervention (mg/day)	p-value
Bread	11.4%	450±352	318±195	0.053
Processed meats	10.8%	370±347	193±240	0.002
Soup	10.3%	385±589	210±303	0.014
Condiments	6.4%	193±234	94±180	0.007
Mixed food grain based	5.4%	178±320	212±293	0.533

Table 4-4 Correlation between changes in intake of sodium from the top five food sources and total reduction in sodium intake

Food sources of sodium	R	p-value
Bread	0.396	0.002
Processed meats	0.293	0.022
Soup	0.523	0.000
Condiments	0.498	0.000
Mixed food grain based	0.175	0.117

Table 4-5 illustrates the changes in primary food sources of saturated fat over the duration of the PANDA trial. More than 20% of total saturated fat intake pre-intervention was from dairy products (cheese and milk). Added fat (butter, margarine and oils), fast foods and processed meats also contributed. Together, these foods accounted for >40% of total saturated fat intake. Daily intake of saturated fat tended to decrease after 3 months (-2.9 g, 95%CI (-6.1, 0.1)) and of the food categories, milk (1-4% fat) and processed meat consumption declined significantly at 3 months, together accounting for nearly 60% of the reduction. Table 4-6 displays the correlation between changes in primary food sources of saturated fat and reduction in saturated fat intake. Reductions in milk, oil, and processed meat consumption were correlated with reduction in saturated fat intake.

Table 4-5 Effect of the PANDA intervention on intake of saturated fat from the top five food sources

Food sources of saturated fat	Contribution at baseline (% of total)	Pre-intervention (g/day)	Post-intervention (g/day)	p-value
Cheese	12%	3.5±3.8	3.3±4.1	0.865
Milk (1-4% fat)	10%	2.7±4.2	1.7±2.1	0.052
Fats/oils	9.1%	2.7±3.4	2.5±3.6	0.710
Fast food	7.4%	1.9±2.7	1.4±3.1	0.263
Processed meats	5.7%	1.7±1.9	1.0±1.7	0.038

Table 4-6 Correlation between changes in intake of sodium from the top five food sources and total reduction in sodium intake

Food sources of saturated fat	R	p-value
Cheese	0.121	0.353
Milk (1-4% fat)	0.346	0.006
Fats/oils	0.489	0.000
Fast food	0.093	0.478
Processed meats	0.332	0.009

Table 4-7 highlights the changes in primary food sources of added sugar in the PANDA intervention. At baseline, desserts (dairy-based or baked desserts) and yogurt were the main contributors to added sugar. Of those reporting yogurt, 18 participants out of 40 consumed fat free yogurt with artificial sweeteners (data not shown). Chocolate, breakfast pastries and breakfast cereals were also main sources of added sugar. These foods accounted for 60% of total added sugar intake at baseline. There was a trend for added sugar intake to decrease (p=0.097) at 3 months, which was accounted for mainly by significantly reduced consumption of pastries/baked desserts and chocolate. Table 4-8 illustrates the correlation between changes in primary food sources of added sugar and reduction in added sugar intake. Only changes in chocolate consumptions were correlated with reduction in added sugar.

Table 4-7 Effect of the PANDA intervention on intake of added sugar from the top five food sources

Food source of added sugar	Contribution at baseline (% of total)	Pre-intervention (g/day)	Post-intervention (g/day)	p-value
Dairy dessert/yogurt	17.3%	7.7±9.4	9.3±11.7	0.296
Baked goods/desserts	13.5%	6.5±9.7	3.8±6.1	0.029
Chocolate	10.9%	2.4±6.6	0.4±1.6	0.026
Breakfast pastries	8.9%	3.9±5.9	3.3±6.3	0.568
Breakfast cereals	8.8%	3.2±5.5	3.4±5.2	0.796

Table 4-8 Correlation between changes in intake of added sugar from the top five food sources and total reduction in added sugar intake

Food source of added sugar	R	p-value
Dairy dessert/yogurt	-0.088	0.502
Baked goods/desserts	0.108	0.408
Chocolate	0.667	0.000
Breakfast pastries	0.140	0.382
Breakfast cereals	0.161	0.216

Table 4-9 shows the number of participants meeting nutritional recommendations for sodium, saturated fat and added sugar at baseline and 3 months. Post-intervention, 13% more participants were under the UL of recommended intake of sodium (2300 mg/day) (Health Canada, 2012a). The number of diabetic participants meeting the recommended intake of saturated fat (<7% of energy) (Dworatzek et al., 2013) at three months nearly doubled (p=0.007) but was still <15%. The proportion of participants meeting the added sugar recommendation did not change. Less than one-quarter of the participants met the WHO recommended intake of added sugar (<5% of energy) and this did not change significantly post-intervention (p=0.180).

Table 4-9 The number of participants meeting the nutrition recommendations for sodium, saturated fat and added sugar at baseline and 3 months (% of total sample)

Nutrition recommendation	Baseline	3 months	P value
Sodium [a]	25.8	38.7	0.017
Saturated fat [b]	6.5	11.7	0.007
Added sugar [b]	66.1	69.4	0.331
Added sugar [C]	23.3	21.9	0.180

[a]- Health Canada upper daily limit (Health Canada, 2007)
[b] - Canadian Diabetes Association clinical practice guidelines 2013 (Dworatzek et al., 2013)
[C] -WHO added sugar recommendation (WHO, 2015)

4.4 Discussion

The main aims of this study were to explore the primary food sources of sodium, saturated fat, and added sugar in people with diabetes in Canada and to determine if a menu plan-based intervention could reduce intakes of these nutrients. At baseline, intakes of sodium and saturated fat were above recommendations in this cohort, whereas added sugar was lower than the recommended not more than 10% of total energy. Overall, the intervention reduced total sodium and some sources of saturated fat consumption. Added sugar intake, already low, was not further reduced. Processed meats emerged as a leading source of both sodium and saturated fat. Other sources of sodium included other processed foods but also bread and grain-based mixed foods, while other sources of saturated fat included dairy products and added fats/oils along with fast food.

It is not surprising that only a quarter of diabetic patients had intakes below the UL for sodium (2300 mg/day) because sodium intake at baseline (3200 mg/d) was similar to the average of Canadian adults (3400 mg/d) (Health Canada, 2012a). The primary source of dietary sodium in this cohort was bread, which is consistent with the general Canadian population (Garriguet, 2009), as well as diabetic patients from Spain (Guallar-Castillón et al., 2013). However, at 11% of total, the amount of sodium from bread was lower than that of Spanish diabetic populations (Guallar-Castillón et al., 2013) or general populations of the United Kingdom and United States (range 20-35%) (Anderson et al., 2010). Although bread is not inherently rich in sodium, high consumption patterns make it a principle source of this nutrient as reported Fischer, Vigneault, Huang, Arvaniti, and Roach (2009) and our study (average intake 2.3 serving/d). As predicted, processed foods were other main sources of sodium. Intakes from processed meats (10.8% of total) were similar to the Canadian population (8.9%) (Fischer et al., 2009). We observed that sodium intake was significantly reduced after the PANDA intervention program by about 18%, primarily because participants consumed less processed foods. Strategies from the PANDA menu plan that may have helped participants included recipes for homemade soups and limited use of condiments, along with lunch recipes using a variety of unprocessed protein sources, and use of herbs and spices to enhance flavor. Improved knowledge of food labeling (covered in the education modules) and increasing the number of homemade meals may have helped to reduce sodium intake in this population (Kitaoka et al., 2013). Although participants reduced sodium consumption, average intake still exceeded the UL of recommended intake. This outcome is similar to those of a 1-year dietary intervention focused on improving dietary quality among metabolic syndrome patients, which showed an overall reduction in sodium intake, but with more than half of participants' intake persistently exceeding the sodium UL (J. Wang et al., 2013). Lowering sodium intake has been associated with reductions in cardiovascular risk (Cook, Appel, & Whelton, 2014) and blood pressure (He, Li, & Macgregor, 2013); therefore it should be a priority in patients with type 2 diabetes. In the PANDA intervention program there was a significant reduction in systolic blood pressure (chapter 3). However, we were not able to find an association between change in sodium intake and systolic blood pressure, probably because the study was not powered to detect this change.

Several studies (Jarvandi, Gougeon, Bader, & Dasgupta, 2011; Muñoz-Pareja et al., 2012), including those from our group (Asaad et al., 2015; Asaad & Chan, 2012; Chan et al., 2014) identify low adherence to recommendations for saturated fat consumption. Almost a quarter of dietary saturated fat in these diabetic patients came from dairy products (cheese and milk), similar to a Spanish diabetic population (Guallar-Castillón et al., 2013), and the general American population (Huth, Fulgoni, Keast, Park, & Auestad, 2013). After the intervention, we observed a significant reduction in saturated fat from milk due to a reduction of fat-containing milk (pre-intervention 0.8±0.9 versus post-intervention 0.6±0.7 servings/day). Consumption of non-fat milk products or alternatives did not increase despite the PANDA menu plan following Canada's Food Guide recommendation to consume 2-3 servings of low- or non-fat Milk and Alternatives daily (data not shown). The intervention also did not reduce the intake of saturated fat from cheese. One explanation is that consumers may not be willing to change to low-fat cheese because of perceived less desirable flavor and texture (Childs & Drake, 2009). Furthermore, the health risks and benefits of dairy are controversial. A previous meta-analysis showed no association between dairy saturated fat and the risk of cardiovascular disease (Soedamah-Muthu et al., 2011), while other studies demonstrated an inverse association between low-fat dairy foods and fluids and risk of hypertension (Ralston, Lee, Truby, Palermo, & Walker, 2012), and increased consumption of hard cheese led to reduced LDL- and HDL-cholesterol (Goede, Geleijnse, Ding, & Soedamah-Muthu, 2015). Another main source of saturated fat came from fats/oils, mostly butter and margarine. Saturated fat consumption from fats/oils was not significantly reduced in this trial; this may be due to the effect of fat on palatability and pleasure of the diet (Drewnowski, 1997). Fast foods also contributed as a main source of saturated fat and this remained unchanged after the PANDA intervention. The Canadian Community Health Survey reported that one-quarter of Canadians had eaten something from fast food outlets daily (Statistics Canada, 2007) a similar proportion to the 15 out of 61 participants in our study. Following the menu plan did not reduce fast food intake which might be due to its convenience and accessibility (Jekanowski, Binkley, & Eales, 2001); two-thirds of Edmonton's neighborhoods have at least one fast food outlet within 500 m (Smoyer-Tomic et al., 2008). As noted above, consumption of processed meats decreased over the intervention period. Recent meta-analysis data demonstrated that processed meats are associated with higher incidence of diabetes and coronary heart disease (Micha, Wallace, & Mozaffarian, 2010). Although participants tended to reduce saturated fat consumption from unhealthy food sources such as fast food and processed meat, healthier food sources of saturated fat such as yogurt and milk tended to increase. Yet nearly 90% of participants did not meet the recommended intake of saturated fat (<7% of energy intake) even after the intervention. This result indicates that diabetic patients have difficulty limiting saturated fat intake, which also as been documented in the general population of Canadian adults (Health Canada, 2012b). Patients may lack of knowledge about what kinds of foods contain high levels of fat (Asaad et al., 2015) or they may actually increase calories from fat after their diagnosis because of the emphasis on sugar/carbohydrate reduction (Ma, Ailawadi, & Grewal, 2013).

Two-thirds of study participants met the recommended intake of added sugar (≤10% of total energy) at baseline, which is consistent with the results of the 2004 Canadian Community Health Survey (CCHS) showing that diabetic respondents consumed less total sugar compared with non-diabetic respondents, possibly due to a focus on carbohydrate management for glycemic control (Langlois & Garriguet, 2011). The primary sources of total sugar were from fruits and vegetables, and dairy products (data not shown). Baked or dairy desserts represent the greatest contributors to dietary added sugar intake in this cohort and the intervention did not change their intake. Although yogurt (a dairy dessert) is perceived to be a healthy food, about 75% of the total sugar is added sucrose or fructose in many varieties (Bell, R.C., unpublished data). Baked goods and chocolate were other sources of added sugar in diabetic patients and intakes of these were reduced after the intervention. In our cohort of diabetic participants, sugar-sweetened beverages contributed little to added sugar intake (4.6 %), whereas in the general population of Canada (Langlois & Garriguet, 2011) and the United States (Huth et al., 2013), such beverages are major sources of added sugar (13% and 33%, respectively). There is controversy about added sugar intake. The Canadian Diabetes Association (Dworatzek et al., 2013) and the World Health Organization suggest that added sugar intake should be less than

10% of total calories (WHO, 2014); meanwhile, the American Diabetes Association (Franz & Evert, 2012) recommend less than 25% of total calories from added sugar. Reductions in added sugar intake can be achieved through increases in healthy food choices that contain essential nutrients and fiber (e.g. fruit). Canadians with diabetes acquire more dietary sugars from fruit than the general population (Langlois & Garriguet, 2011) and after the PANDA intervention the Whole Fruits category of the Healthy Eating Index increased by 0.3 ± 1.3 serving ($p=0.059$).

The main strength of this study is its novelty in identifying the primary food sources of sodium, saturated fat, and added sugar in Canadian diabetic patients. Additionally, dietary intake data were collected through validated methodology, multiple 24-hour recalls. Although 24-hour recall is a valid method to measure sodium intake, random and systematic measurement error may occur. For example, participants may underestimate or overestimate portion size, or forget to report food items. In our study, none of the participants reported salt added in cooking or at the table in their dietary intake. In contrast, a 24-hour urine is a valid and more accurate method to estimate sodium intake (Bentley, 2006) but would not allow us to determine food sources. Ideally, one could combine the two methods to validate total intake while still being able to document the most important dietary sources of sodium and by performing 24-hour recalls pre- and post-intervention we were able to evaluate how food sources of these nutrients changed. The study had several limitations. Small sample size limits the ability to conduct multivariate or subgroup analyses (such as gender or age effects). The majority of participants lived in an urban area, was educated, Caucasian, and had high incomes/socio-economic status. Therefore, results may not be generalizable to those living in rural areas, with lower education levels, low income or different ethnicities. Additionally, dietary measurement error may have occurred due to inaccurate reporting by participants or limitations of the WebSpan database. For example, none of the participants reported added salt in their food intake, while WebSpan could not distinguish between homemade versus prepared food items. However, these limitations would be expected to dampen the true effects, thus conclusions regarding dietary changes are probably conservative.

In summary, the study highlights the main food sources of sodium, saturated fat, and added sugar in Canadian diabetic patients. Providing knowledge and skills regarding healthy food choices and menu planning through the PANDA intervention enabled healthy behavior changes resulting in significantly lower sodium intakes and a general reduction in processed foods such as meats and soups. However, continuing on a healthy diet may be challenging in terms of preventing diabetes complications. Although there were improvements in dietary intake, the majority of participants still had difficulty achieving recommended saturated fat and sodium intakes. Meeting these recommendations would require the development of strong public health policies for food industries to reduce saturated fat (Downs, Thow, & Leeder, 2013), sodium (G. Wang & Labarthe, 2011), and added sugar (Gornall, 2015) content in foods. In Canada, only 8.7% of food products had claims about saturated fat, 4.5% claims about sodium, and 4% claims about sugar (Schermel, Emrich, Arcand, Wong, & L'Abbé, 2013). Nowadays, many people don't prioritize time for food preparation, thus contributing to changing food consumption patterns such as an increase in the consumption of fast foods and convenience or ready-to-eat foods. If the food industry increased the number of products with healthier profiles of saturated fat, sodium and added sugar, diabetic consumers would have greater access to appropriate foods (Jabs & Devine, 2006). Our findings can assist dietitians and other healthcare professionals in understanding dietary patterns of diabetic patients, which may enhance efforts to improve adherence to saturated fat, sodium and added sugar recommendations.

Chapter 5. Discussion

This chapter firstly summarizes the key findings in Chapters 2-4 of this thesis, and highlights the importance of each study in the context of the thesis. This chapter also illustrates the contribution to the literature of this research on dietary assessment for diabetic patients and the nutrition intervention for Albertans. Additionally, the implications of these studies for future applications of dietary assessment and nutrition intervention for T2D patients, as well as the limitations and strengths and recommendations for future research are presented.

5.1 Summary of objectives and results

One purpose of this thesis was to address an identified gap in current dietary assessment for adults with T2D by creating the Perceived Dietary Adherence Questionnaire, and to assess its validity and reliability. In addition, I evaluated the effectiveness of the PANDA menu plan plus education sessions among T2D clients in terms of diet quality and adherence and clinical improvement in glycemic control. To further understand how the intervention influenced food choices, I conducted an analysis of food sources of sodium, saturated fat and added sugar in the diet of the PANDA cohort before and after the intervention.

5.1.1 Discussion for objective 1

Objective 1: To measure the reliability of Perceived Dietary Adherence Questionnaire and its validity relative to three repeated 24-h dietary recalls among T2D patients.

The purpose of this work was to create a valid and reliable instrument for use in research purpose that reflects current Canadian recommendations for a diabetes diet (Chapter 2). The questionnaire consists of a total of 9 questions structured to cover the CDA Nutrition Therapy guidelines [18] with reference to following CFG. The response is based on a seven-point Likert scale. PDAQ takes approximately 5 minutes for participants to complete and one minute to calculate the score, which was based on a maximum of 7 for each item (with the items for consumption of foods high in sugar and fat inversely scored), for a total maximum score of 63. Higher number indicates high adherence to Canadian recommendations for a diabetes diet. Total score of the PDAQ was positively associated with total score for the HEI, suggesting that the PDAQ was a valid tool to measure diet quality in adults with diabetes. PDAQ was moderately positively associated with age, indicating older adults exhibited better diet quality. A significant negative correlation was found between PDAQ score and weight, indicating obese patients are less likely to adhere to the nutrition recommendations. However, there was no association between PDAQ and A1c value; this may be due to small sample size (n=64). Only a few studies have shown an association between glycemic status and the diet quality in patients with diabetes. An analysis based on 7441 participants of the Australian Diabetes, Obesity and Lifestyle study found an association between higher diet quality and A1c in men only (McNaughton, Dunstan, Ball, Shaw, & Crawford, 2009). Another study did not find an association between A1c and Diet Quality Index or HEI; only the Mediterranean Diet Score Healthy Diet Indicator showed a significant negative correlation with A1c (Kim et al., 2013).

Compared with a repeated 24-h recall, PDAQ also appeared to be valid for assessing adherence to current nutrition recommendations for a diabetes diet; the correlation ranged from 0.46 to 0.11. No correlations between spacing carbohydrates, foods high in n-3 fatty acids, and healthy oils versus the actual intakes were found. The lack of correlation between self-reported carbohydrate spacing and the carb spacing score derived from 24-h recalls may be explained by lack of knowledge among diabetic patients (Watts, Anselmo, & Kern, 2011) or that some patients with T2D did not use carbohydrate counting; those that did use carbohydrate counting were more likely to be taking short-acting insulin (Dias et al., 2010). No significant relationship was observed between questions related to foods high in n-3 fatty acids, and healthy oils and the actual intake of unsaturated fat, a result consistent with findings using the Dietary Fat and Free Sugar – Short Questionnaire (Francis & Stevenson, 2013). This may be due to lack of knowledge by participants of foods that contain these fats and oils.

The internal consistency of the PDAQ was within the stipulated acceptable range of Cronbach's α (0.78), indicating the PDAQ had good internal consistency without deletion of any questions. Test and re-test reliability was assessed by the intra-class correlation. High to moderate correlations were obtained for five items on the PDAQ (fruits and vegetables, foods high in sugar, foods high in fiber, fish and other foods high in n-3 fatty acids, and healthy oils) ranging from 0.85 to 0.46. Overall, the PDAQ had good stability over time with r=0.77. PDAQ was then used in PANDA intervention study (Chapter 3), and was shown to be able to detect changes in diet over time (see Chapter 3).

5.1.2 Discussion for objective 2

Objective 2: To evaluate the effectiveness of the menu plan plus education sessions among people with T2D in improving glycemic control and promoting dietary changes.

In this experimental study (Chapter 3), a four-week menu plan based on the principles of the 4-A Framework was developed for Albertans with T2D to enhance behavior change and to improve glycemic control. As was previously suggested, the four-week menu plan may be an excellent strategy to improve dietary adherence. Simple recipes, affordable, accessible and available ingredients were all factors that we took into account when choosing the menu items and recipes. The menu plan includes weekly grocery lists and cooking tips that facilitate dietary adherence. Focus group interview from our pilot study (Soria-Contreras, Bell, McCargar, & Chan, 2014) showed that menu plan was acceptable for the participants and it was clear and easy to follow. The recipes taste delicious, and the variety of foods available for selection were facilitators to diet adherence that participants mentioned. The ability to modify recipes based on each participant´s lifestyle or preferences was another acceptable component. Diet acceptability predicted the HEI score at baseline and increased significantly after the intervention, suggesting that providing people with specific examples of acceptable diets could improve diet quality and health outcomes (Asaad et al., 2013). The ingredients were accessible and available in Alberta. Providing locally grown or imported ingredients (Food Availability) may have increased feasibility for the participants to adopt the menu plan. Most recipes used affordable ingredients (Food Accessibility) to help overcome the barrier related to food prices. Therefore, the 4-A Framework underpinning the PANDA menu plan helped to ensure adequate nutrient intake (Food adequacy), and improve diet adherence and health outcomes among individuals with T2D.

The primary outcomes were A1c (glucose control) and diet quality (HEI, PDAQ scores). Overall, the A1c was significantly reduced by 0.7%. This change is consistent with our pilot study (Soria-Contreras, Bell, McCargar, & Chan, 2014), and with the results of a recent systematic review and meta-analysis of the effectiveness of lifestyle intervention in adults with T2D (Chen et al., 2015). Secondary biological outcomes with significant changes in the whole cohort included those related to body composition, blood pressure and lipids. Modest reduction in weight (1.7 kg), BMI (-0.6 kg/m^2), waist circumference (-2.4 cm), fat mass (-1.2 kg), and fat mass % (-0.8%) indicate that the PANDA intervention focused on menu planning is supportive of weight loss. Although reduction in BMI was modest (-0.6 kg/m^2), it was the strongest predictor of improved A1c, with -1 kg/m^2 predicting a 0.1% reduction in A1c. Our results are consistent with the Look AHEAD cohort trial (Wing et al., 2011), which showed that a modest weight loss of 2-5% was associated with significant improvement in A1c (1.80% [95% CI 1.44–

2.24]) and other CVD risk factors at 1 year. The inverse relationship between changes in A1c and serum HDL-C shown after the PANDA intervention has also been reported by others (Ahmad Khan, 2007; Gatti et al., 2009), indicating that the PANDA intervention may be beneficial to improve CVD risk factors. Significant improvements were still found across anthropometric variables (weight, BMI, waist circumference), lipid profile variables (total cholesterol, HDL, LDL), and A1c after 6 months. These results suggest the effectiveness and sustainability of the menu plan program to improve clinical outcomes despite the fact that the intervention focused on nutrition education and healthy eating patterns, not weight loss or blood sugar control.

In addition to providing evidence for the effectiveness of the PANDA intervention to promote glucose control and improved CVD risk factors, this study (chapter 3) highlighted changes in diet quality and absolute nutrient intakes. Diet quality measured by the HEI improved modestly after 3 months. However, at baseline 11% of participants were classified as having good diet quality (HEI > 80), and after 3 months 20% were classified as such (an increase of 5 individuals). When HEI subscales were examined, the improved total score was attributable to increased fruits and vegetables, particularly whole fruits along with decreased saturated fat and sodium. Fiber intake (22g) was lower than recommendations at baseline, and no changes in dietary fiber were observed after the intervention. This could be explained by improvement in total score from fruits and vegetables, particularly whole fruits; meanwhile, total grain score decreased significantly by -0.4 out of 5. We found a significant improvement in the PDAQ score after 3 months (+8.5 points), which indicates that PDAQ may be more sensitive to behavioural change than assessment of dietary intake because it asked specific questions about fiber and glycemic index, for example. With regard to individual nutrients, the PANDA intervention resulted in reduction of total energy (-178 kcal), total fat (-10.2 g), saturated fat (-

3.5 g), added sugar (-8.5 g), sodium (-0.57 g), and sodium density (-0.14 mg/1000 kcal). The small reduction in average energy intake was consistent with the magnitude of weight loss observed. While total amounts of fat and sugar decreased, there was little change in the overall diet composition (ie., % of calories from fat or carbohydrate). Perhaps the biggest change in diet was a reduction in sodium intake that was still observed after adjusting for energy intake changes. This improved sodium consumption pattern may reflect changes in eating habits of study participants, for example reduction in sodium from processed foods from 370±347mg to 193±240 mg, and soup from 385±589 mg to 210±303 (Chapter 4 and as discussed below).

5.1.3 Discussion for objective 3

Objective 3: To identify primary food sources of sodium, saturated fat, and added sugar at baseline and determine how each was changed by participation in the PANDA intervention study after 3 months.

In this exploratory study, we identify primary food sources of sodium intake among people with T2D. Bread was the major source of sodium for diabetic participants. Other important sources of sodium included processed foods (luncheon meats, soups, condiments) and grain based mixed foods such as pasta dishes. The total contribution of sodium from these five top sources was >40% of intake (about 1300 mg/day). After the intervention, the consumption of luncheon meats, soups, condiments were decreased. These changes in food choices may be explained by the influence of the intervention and the menu plan, for example in replacing processed soups with homemade soups, and replacing condiments with herbs and spices to enhance flavor. It was not surprising that only a quarter of diabetic patients had intakes below the UL for sodium (2300 mg/day) because sodium intake at baseline (3200 mg/d) was similar to the average of Canadian adults (3400 mg/d). After the intervention, 38% participants were under the UL of recommended intake of sodium (2300 mg/day) (an increase of 8 participants).

The study showed that the majority of saturated fat consumed by T2D patients was found in dairy products (cheese and milk), added fat (butter, margarine and oils), fast foods and processed meats. These foods accounted for >40% of total saturated fat intake. Few participants (6.5%) met the recommended intake of saturated fat (<7% of energy) at baseline, and at three months 11.7% met the recommended intake of saturated fat. It was not surprising that few diabetic patients met the recommended intake of saturated fat pre- and post-intervention because almost a quarter of intake came from dairy products (cheese and milk). This result indicates the reduction came from processed meats. Diabetic patients have difficulty limiting saturated fat intake, which also as been documented in the general population of Canadian adults (Health Canada 2012).

Although intakes of sodium and saturated fat were above recommendations in this cohort, added sugar was lower than the recommended (not more than 10% of total energy). This result is consistent with the results of the 2004 Canadian Community Health Survey (CCHS) showing that diabetic respondents consumed less total sugar compared with non-diabetic respondents (Langlois & Garriguet, 2012). Pre-intervention, more than half of participants met the recommended intake of added sugar, and after the intervention 69.4% participants met the recommendation. Desserts (dairy-based or baked desserts) yogurt, chocolate, breakfast pastries and breakfast cereals were main sources of added sugar. After the intervention, there was a significant reduction in pastries/baked desserts and chocolate consumption. This finding might be attributable to changes in the dietary habits after nutrition intervention.

5.2 Contribution to the literature

In this thesis I developed a short questionnaire to measure the adherence to CFG and CDA recommendations in individuals with T2D. To the best of my knowledge, this is the first study in the literature to measure the dietary adherence to recommendations in this population. Traditional dietary intake measurement such as by 24-hour recalls, FFQs and food records require administration and analysis by a skilled health care professional, and as a result are associated with high burden. A few studies have developed questionnaires to measure the adherence to disease-relevant guidelines (Pullen & Noble Walker, 2002; van Lee et al., 2012) or specific diets (Hong et al., 2010; Mochari, Gao, & Mosca, 2008) and previously there was no short questionnaire to measure adherence to CFG and CDA recommendations in Canadians with T2D. To simplify the collection of dietary information, and to assess dietary adherence, PDAQ was developed. The PDAQ is an innovative method for the assessment of diabetic patients' perceptions of their dietary adherence, and has shown promise in reducing participants' burden while capturing dietary habits. Although its correlation with 24-hour recall data was moderate, the PDAQ may be more sensitive to elements of diet important for diabetes control because it asks specific questions about glycemic index and fiber intake, for example.

There have been many studies in the literature showing the effectiveness of nutrition education programs in preventing diabetes such as the Finnish Diabetes Prevention Study (Tuomilehto et al., 2001), the US Diabetes Prevention Program (Knowler et al., 2002), the China Da Qing Diabetes Prevention Study (Li et al., 2008), the Indian Diabetes Prevention Programme (Ramachandran et al., 2006). A smaller number of large trials report on treatment of diabetes such as the Look AHEAD study (Look AHEAD Research Group et al., 2007). None of these studies were conducted in Canada. All of these studies focus on weight loss, reduction in total energy, and increasing physical activity.

Few diabetes programs have developed in Canada with results reported in the literature. Canadian Aboriginal populations have higher prevalence diabetes rates compared to the general population (Young, Reading, Elias, & O,Neil, 2000) and are often geographically challenging to reach. The Okanagan Diabetes Project was developed to test the effectiveness of community-directed diabetes prevention and control in a rural Aboriginal population in British Columbia, Canada. The intervention had many activities included: aerobics and gentle exercise classes, walking group, health events, cooking demonstrations, smoking cessation group, supermarket and restaurant tours. Lack of effectiveness of this program was documented (Daniel et al., 1999). A 24-week program for T2D patients in Montreal, Quebec combined self-monitoring strategies such as weight change, step count, and meal preparation. The program successfully reduced weight, A1c, and blood pressure, as well as inducing dietary changes (Dasgupta et al., 2012). Another study conducted by (Bader, Gougeon, Joseph, Da Costa, & Dasgupta, 2013) tested the effectiveness of a 24-week Internet-based menu-planning program. The program elicited clinically significant reduction in weight and improvement in glycemic control and blood pressure. Our study has differences respective to other studies, such as those mentioned above. The PANDA program did not focus on weight loss, rather the emphasis was on dietary behavior changes. In accordance with the 4-A Framework (See Section 3.2.3), a nutritionally adequate 4-week menu plan that incorporated the CDA nutrition recommendations and met the CFG serving recommendations was developed. Recipes were consistent with the principles of diabetes management, and personally and culturally acceptable. The ingredients were accessible and available in Alberta. The small-group program was developed using the Social Cognitive Theory approach, and active group processes were used to enhance nutrition knowledge, self-efficacy, and behavior change for health promotion in adult with T2D.

5.3 Implications

The PDAQ offers a simple and instantaneous method of measuring diabetic patients' perceptions of their dietary adherence. Since understanding dietary patterns in research may be important for interpreting outcomes, we suggest that the PDAQ may useful to help accomplish this objective and that it can be implemented in research. Furthermore, PDAQ may be worthwhile to test in a clinical setting because it can provide information on key indicators of food intake and food habits rapidly. Although the CDA does not have a specific recommendation for sodium, addition of an item related to sodium intake could be a useful addition to the PDAQ because sodium intake can be indicator of health outcome. The study also did not calculate cut-off values for the PDAQ that relate to good diet (in the way that the HEI has cut-offs for *poor, needs improvement* and *good* diets) because the sample size was relatively small (n=64). A larger sample size, in addition to a great diversity of participant characteristics is suggested for classification of diet adherence as insufficient, good or excellent. Although validated from a statistical standpoint, the PDAQ could undergo further refinement. For example, the literacy level of the questionnaire was not evaluated. According to the Canadian Council on Learning, by 2031 more than 15 million Canadian adults will have low literacy levels (The Excellence in Literacy Foundation, 2016). Adults with low literacy levels have more health problems than those with higher literacy levels (Weiss, Hart, McGee, & D'Estelle, 1992). It may be worthwhile to simplify the language used in the PDAQ for applications of assessing dietary adherence of adults with low literacy levels.

The findings of the PANDA intervention study support using a menu plan plus education sessions in diabetes management. Evaluation of implementing the PANDA intervention in a primary care setting is warranted. The benefits of primary care providers facilitating the PANDA intervention in diabetes self-management in patient with T2D or pre-diabetes may equate to saving Alberta healthcare money by preventing or delaying the costly consequences of diabetes-associated complications. Cost-effectiveness analysis helps identify the costs and health effects of an intervention relative to usual health care. Few studies have been conducted in Canada to estimate the cost-effectiveness of behavioral treatments for diabetes. Caro et al., 2004 conducted an economic evaluation of a therapeutic intervention among Canadians with pre-diabetes but did not examine benefits in people with diagnosed diabetes. Lifestyle modification (lifestyle + medication) reduced the number of diabetes cases more than metformin or Acarbose (medication alone), and no treatment groups. The analysis concludes that lifestyle modification is cost-effective in terms of diabetes prevention and saving health care expenditures. With respect to pharmaceutical agents, Grover et al. (2000) conducted a cost-effectiveness study to estimate the long-term costs and benefits of treatment with simvastatin among diabetic patients with hyperlipidemia. Simvastatin was effective and cost-effective in reducing CVD risk factors in these patients. The cost-effective of early intervention with irbesartan to delay end-stage renal disease in patients with type 2 diabetes and early renal disease was proven (Colye et al., 2007). Thus, none of these studies estimate the cost-effectiveness of lifestyle modification in diabetes patients. Because of rising healthcare costs and limited budgets, I would recommend a RCT to evaluate the cost-effectiveness of PANDA intervention among T2D patients because of the potential to provide valuable information regarding the cost associated with the health gain.

The intervention study described in this thesis was conducted in an urban area in Alberta, and it would therefore be beneficial to conduct a program in rural communities in Alberta. People living in rural areas have a higher risk of diabetes as well as higher levels of mortality and morbidity (Public Health Agency of Canada, 2011). Fairview a rural remote area showed high prevalence of diabetes 5.7 % compared with Bonnie Doon (low-income neighbourhood) 4.9%. In central Calgary the prevalence of diabetes 4.7% in 2012, meanwhile, Athabasca had

5.4% prevalence of diabetes (Alberta Health, 2015). Non-diabetic patients at Wetaskiwin a small city in Alberta had higher proportion of A1c test compared with Edmonton, and Red deer (large cities) (Lyon, Higgins, Wesenberg, Tran, & Cembrowski, 2009). Albertans living in rural northern Alberta were less likely to meet recommended targets for control of glycemia. Only 10.4% of patients with T2D met three recommended targets for control of glycemia: A1c < 7, blood pressure <130/85 mm Hg, and LDL <100 mg/dl (Toth et al., 2003). However, other populations may also struggle to attain targets, not just those living in rural communities. For example, in St. John's, Newfoundland a chart audit revealed that only 2% of patients met all three criteria (McCrate, Godwin & Murphy, 2010). While it is not clearly established from these data that rural Albertans with diabetes are worse off than their urban counterparts, it seems likely that patients in remote communities have less access to programming or routine screening. In the past, access to screening was enhanced through a mobile clinic but this service has been discontinued (Oster, Ralph-Campbell, Connor, Pick & Toth, 2010; Oster, Shade, Strong & Toth, 2010; Oster, & Toth, 2010).

Numerous barriers to healthy promotions exist in Canadian population includes: lack of interest, lack of funds and/or resources, lack of leadership, lack strong partnerships, lack of time to develop, geography distance, and poor communication. On the contrary, facilitators that contribute to healthy promotions are appropriately skilled and/or committed people, funds and/or resources, local leaderships, strong partnerships, strong communications and adapts to local needs (Robinson, Driedger, Elliott & Eyles, 2006).These barriers and facilitators need to be considered if a PANDA intervention were to be implemented as part of the diabetes treatment program provided by Alberta Health Services. To implement the PANDA intervention study within Alberta Health Services, knowledge translation is the best practice to bringing researchers and decision makers together. The Canadian Institute Health Research (CIHR) defines knowledge translation as “a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system” (Canadian Institute Health Research, 2015). The CIHR uses a Knowledge-To-Action Cycle framework to illustrate how interventions may be implemented. The first step in starting knowledge implementation is to identify gaps in provision of services to the population through the literature, which we already identified as “food environmental factors affecting adherence to diabetes nutrition therapy recommendations”. The second step is to adapt knowledge to local context. Because food environmental factors affect adherence to diabetes nutrition therapy recommendations, the PANDA team designed a four-week menu plan focussing on the local context of Alberta. The menu meets the serving recommendations and macronutrient content suggested Canadian Diabetes Association nutrition therapy guidelines. The menu design took into consideration the 4-A Framework criteria (nutritionally adequate, available, accessible, and acceptable foods). The third step is to assess barriers to knowledge use. To address this, the menu plan was testing in a pilot study. The study showed that the menu plan is a good tool in term of improving glycemic control and health outcomes (Soria Contreras et al, 2014). A focus group interview was conducted to gather participants’ feedback about the menu plan. Barriers to follow PANDA menu plan was time consuming to prepare some recipes, and excessive ingredients (Soria Contreras et al., unpublished data). These barriers were taken into count when we developed a revised version of the menu plan for the larger study. The fourth step is to select, tailor, and implement interventions. This step was approached through a large study (n=73) incorporating a structured education program with lots of opportunity for skill-building and increasing knowledge along with use of the menu plan. The fifth step is to monitor knowledge of the patients by measuring patient knowledge and attitudes, which was done with a DSES and

PDAQ. The sixth step is to evaluate outcomes. We evaluated the effectiveness of the PANDA nutrition intervention on glycated hemoglobin (A1c), anthropometry, blood pressure, lipid profile and dietary adherence to national diabetes guidelines for nutrition therapy pre- and post-intervention.

The last step is to sustain knowledge use depends not only on patients' attitudes and social networks, but also on external environmental factors such as leadership in development of supportive policies, as well as financial and political supports within the healthcare system. This can be achieved through community-based project implementation. The sustainability depends on the ability of workers and organizations (e.g., Primary Care Networks) to facilitate PANDA nutrition intervention into the broader community. Leaders and managers at all levels of the Knowledge-To-Action Cycle must be involved to ensure the outcomes are met. Policy makers are also involved in project sustainability. They will determinate how to integrate a new knowledge translation into the health care system. Funding is also anther important component of knowledge translation sustainability. The cost effectiveness study will help to determine whether the costs and health effects of the PANDA intervention are favourable relative to usual health care. Project sustainability requires political support. Their support and funding can impact on phasing out the sustainability.

Our sample population was adults with T2D. In the last two decades, T2D has significantly increased in the pediatric population, due to obesity. Children of non-Caucasian ethnicity (Aboriginal, African, Arab, Hispanic, and Asian) have a high prevalence of T2D (Riddell & Sellers, 2013). Sung-Chan and his colleagues conducted a systematic review to examine the methodology and treatment effectiveness family-based intervention in obese children. Involving one or the whole family member in the intervention was more effective than family-based interventions, and family therapy in obese children (Sung-Chan, Sung, Zhao & Brownson, 2013). Few studies of family-based interventions have been conducted among youth and adolescents with T2D. The Treatment Options for Type 2 Diabetes in Adolescents and Youth (TODAY) study was designed to compare metformin alone, metformin plus rosiglitazone or metformin plus an intensive lifestyle intervention in children. The study showed that metformin plus rosiglitazone was more effective than metformin alone, or metformin plus an intensive lifestyle intervention (Zeitler et al., 2013). A PANDA-like family-based intervention for children and a parent with T2D could be useful because of the emphasis on healthy meals to address the high prevalence of T2D in both the adult and pediatric population.

In addition, the outcomes addressed in this thesis were dietary adequacy and adherence and biological outcomes. Further research is needed to establish knowledge about other factors (available, accessible, and acceptable foods) to be able to gain a better understanding of the perception of health behaviors, nutrition behaviors, and factors that may influence food choices in the context of the 4A Framework.

5.4 Strengths and limitations

This PANDA project had strengths. First, the 4A Framework was used as a novel guide to developing the intervention. To establish dietary adequacy, we translated the complex CDA nutrition recommendations, and the serving recommendations suggested by CFG into a simple and practical menu plan, around which the education program was built. Second, the menu plan also took into consideration food environment factors such as availability, accessibility, and acceptability. Third, the study was able to measure several outcomes including A1c, anthropometric measurements, and lipid profile at the end of the intervention and 6 months after the final contact. Fourth, we used three internet-based, 24-h dietary recalls to estimate dietary intake, a method that has less bias than some others as well as a novel, validated questionnaire (PDAQ) to assess participant perceptions of dietary adherence to complement the HEI (based on dietary recalls). Fifth, the study had a low attrition rate of 15%.

This PANDA project had some limitations. First, the study did not include a control group and participants were self-selected volunteers, which may affect overall motivation. Second, the majority of the participants were Caucasian; therefore, we cannot generalize the results to all ethnicities, which may be important due to the influence of culture on food acceptability and availability. Third, all participants lived in an urban area; therefore, the result may not be generalizable to those living in rural areas. Fourth, the study did not assess dietary adherence in the follow-up assessment.

5.5 Conclusions

This scholarly project sought to provide evidence for the effectiveness of the PANDA nutrition intervention. The menu plan was based on the 4-A Framework for content and the intervention utilized Social Cognitive Theory for process. The results demonstrated significant improvements in A1c, diet quality and perceived dietary adherence, as well as anthropometric variables (weight, BMI, waist circumference), lipid profile variables (total cholesterol, HDL, LDL) and blood pressure after 3 months. Sustained A1c, anthropometric variables, lipid profile variables improvement were also found at 6 months. These results suggest the effectiveness and sustainability of the menu plan program to improve clinical outcomes despite the fact that the intervention focused on nutrition education and healthy eating patterns, not weight loss. The result has also shown changes in food sources of sodium, saturated fat, and added sugar over the duration of a dietary intervention. This thesis also determined the criterion validity and test-retest reliability for PDAQ. Both the PANDA intervention program and PDAQ have the potential to be implemented in primary care settings.

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Appendix 1

PANDA project: FACILITATOR GUIDE AND RESOURCE

BACKGROUND INFORMATION

Goals of the program:

Increase self-management skills, particularly with respect to diet
Reduce A1c
Short- and long-term behavioral change

What is the PANDA project?

PANDA (Physical Activity and Nutrition for Diabetes in Alberta) is a project designed to increase adherence to a healthy diet and physical activity in the diabetic population living in Alberta. The PANDA project is one of the first studies examining food environmental factors such as food availability, accessibility and acceptability in the context of type 2 diabetes.

Why was the PANDA project developed?

Successful diabetes care depends on following both a diet and an exercise plan, self-monitoring blood glucose, and taking medications as recommended by the Canadian Diabetes Association. Nutrition therapy is a crucial part of type 2 diabetes treatment and self-management. Nutrition therapy is also important in the prevention of diabetes complications, and in the prevention of new cases of the disease.

Some researchers have tried to identify the barriers to dietary adherence using the 4-A Framework. The 4-A Framework suggests that foods in nutrition programs should be adequate, accessible, acceptable and available. The PANDA research team designed the PANDA project to improve food availability, accessibility, acceptability and adherence to Nutrition Therapy Guidelines. Therefore, the participant's ability to navigate the food environment will be improved by this program supporting and promoting healthy eating.

What is PANDA program curriculum based upon?

The PANDA program curriculum is based upon Social Cognitive Theory, which suggests that behaviour change is facilitated if the person believes in the desired outcome, perceives that change is possible, has the opportunity to develop and practice skills, and receives feedback about their success in performing the behaviour so that they can become more proficient. A key part of this process is an iterative approach to solving a problem that includes defining the problem, critical inputs, mediating processes, expected outcomes, extraneous factors and implementation issues, as described by Lipsey (1993).

Problem Definition – despite the well-known benefits of healthy eating for individuals with type 2 diabetes, adherence to nutrition recommendations is low.

Critical Inputs – from previous studies, we know that most successful nutrition interventions involve regular contact and follow-up, simple and specific direction, ability to be individualized to ability, lifestyle and preferences.

Mediating processes – gaining self-efficacy is promoted through active learning experiences, encouragement through self-selected goals, feedback, observing other participants' success, encouragement from the facilitator and peers.

Expected outcome – For PANDA participants, improved dietary management is the immediate goal. Long term goals include improved glucose control.

Extraneous factors – participant and facilitator characteristics, social support, group rather than individual counselling. Understanding these may help to explain differences in levels of success achieved by participants.

Implementation issues – available resources (setting, equipment), recruitment and follow-up, facilitator skills and training. We anticipate that the PANDA program is simple enough to be delivered in a variety of settings. Although there are some equipment demands (cooking facilities), minimal facilitator training is required for those with an appropriate background.

Phases of the PANDA program
Adoption phase

The adoption phase is 6 sessions over 6 weeks. In each meeting there will be specific dietary advice, individual goal setting, self-monitoring, and group discussion.

Between each session, participants will reflect their diet adherence in the previous week. Also, participants will write about the barriers to diet adherence they experienced during the week, and any solutions they developed.

Adherence phase

The adherence phase represents longer-term uptake of the lessons learned in the Adoption Phase. In this research program it will last approximately 2 months but in reality it is hoped that adherence is a lifetime achievement.

FACILITATING THE PANDA PROGRAM

General suggestions for the facilitator:

1. Arrive early and greet participants.
2. Encourage participants to learn each other's names. Allow the participants time to chit-chat at the beginning of the session before starting the presentation. At the beginning of the session, provide each participant with a name tag.
3. Get to know the participants. Participants are likely to participate and respond more positively if they are viewed as an individual. Try to remember names.
4. Create an atmosphere where everyone feels comfortable and is included in the discussions.
5. Encourage participants to talk and ask questions.
6. Acknowledging responses will help you build a rapport with participants.

Suggestions for great beginnings:

1. Visit the meeting room before the meeting to make sure that all supplies and equipment are ready. Also, make sure there is appropriate lighting and temperature.
2. Be friendly and approachable with everyone. This will encourage participants to ask questions and participate in discussion.
3. Expect some awkwardness because it is normal for the participants to be anxious or uncertain during the first meeting.

MATERIALS FOR EVERY WEEK

1) Book dining room
2) Book projector
3) Laptop
4) Money for parking
5) Paper
6) Cash for parking

MEETING 1

Items needed for this week:

- <u>Workbook</u>
- <u>Diet record from participants (remind to bring this)</u>
- Name tags and pens
- Food demos for CFG serving sizes
- Household measures
- Samples of food to do serving size activity – *grapes (svg 0.5 cup), cheese (50 gr), nuts (0.25 cup), and cereal (30 gr).*
- Bowls, plates (cup, teaspoon, tablespoon) for serving size activity
- Paper to report food allergies

Icebreaker activity (5-10 min)

Ask the participants to introduce themselves to the group and to answer a couple of questions about themselves, such as:

What reasons bring you to this program?

Can you describe something where you succeeded in changing a behaviour?

The answers to these questions will help you understand the motivations of the people in the program. Hopefully, by thinking of another time that they successfully changed a behaviour, it will reinforce the idea that change is possible.

Introduction

[Slide 2]- Program goals

Explain to everyone:

[Slide 3]- Healthy eating is essential in treating type 2 diabetes. Sometimes people find changing their eating habits to be difficult. The PANDA program will help you understand and plan a healthy diet in "bite-sized" pieces.

Activity – allow 3 minutes

Ask the participant why they think it's important to have a healthy diet with diabetes.

<u>Activity - allow 10 minutes</u>

[Slide 4]- Break the participants into two groups. Ask them to write in their **<u>workbook</u>** what they think they will gain from taking part in this program and what they think they will lose. Also what the people around them (family, friends, co-workers) will gain and lose. Then ask participants to share with each other about the most important challenges that they face. It's really important to get people to talk about potential solutions, strategies or plans, not just how hard it's going to be.

[Slide 5, workbook page 2]- Eating well with Canada's Food Guide

Explain to everyone:

Eating Well with Canada's Food Guide is recommended for all Canadians for healthy eating. Since it was introduced in 1942, Eating Well with Canada's Food Guide has changed as scientists discover more about the effect of food on health. The Guide provides information in 10 different languages to promote good health and reduce the risk of chronic diseases through diet and physical activity. Today we are going to focus on the Food Guide and portions.

There are four food groups that you should consume every day.

Ask participants to name the 4 food groups and the types of foods in each group. When there is a good list of ideas, show everyone the slide **[Slide 6].**

<u>Activity - allow 2 minutes</u>

For each food group, using the chart in your workbook (page 3), circle the number of servings that you need every day.

[Slide 7, workbook page 4]- What do we know about Food Guide servings?

Here is an example for one serving for each of the food groups. For instance: half a cup of juice is considered one serving while one apple is considered one serving.

<u>Use food demos here to demonstrate serving sizes</u>

Explain EWCFG in more detail:

- The rainbow shows that we should eat more fruits and vegetables, then grains, and less milk and meat.
- Fruits and vegetables are source of carbohydrates, fiber and lots of vitamins and minerals. There are many vegetables that contain almost no carbohydrate and are considered as free. Explain the servings and recommendations.
- Grains are a source of fiber, carbohydrates, and vitamins. Explain the servings and recommendations.
- Milk products are a source of protein, fat and minerals like calcium. Explain the servings and recommendations.
- Meat and alternatives are a source of protein and fat. Some alternatives such as beans are a source of carbohydrates. Explain the servings and recommendations.

Others: where do pastries, cookies, granola bars, sugar belong to? The problem is that sometimes we eat too much of other foods. Does some remember how many other foods day had in any of the dietary recalls?

Emphasize that this foods must be limited in the diet and some of them such as granola bars and cookies may turn into good options if we pay attention to their quality

[Slide 8, workbook page 5]- How to count Food Guide Servings in a meal.

When we prepare a meal it usually consists of different foods from each food group. Here is an example.

[Slide 9, workbook page 5]- <u>Activity - allow 5 minutes</u>

Let's figure out how many servings of each food group are in this meal according to Eating Well with Canada's Food Guide. When everyone has had enough time, go over the appropriate answers.

Chinese egg noodles- 2 servings of grains; sirloin steak strips 1 svg of meat & alt; broccoli, red pepper, celery, onion 2 svg fruits & veg; cashews 0.5 meat & alt; peanut oil 1 svg added oils & fats.

Making the connection between food and blood sugar

Explain that carbohydrate intake have the most significant effect on blood sugar compared to protein and fat. However, carbohydrates are the preferred source of energy for our brain and body to work effectively and also a source of vitamins, minerals and antioxidants. When consuming carbohydrates we need to pay attention to the portions, time and the combination of foods, and also the quality of the carbohydrates.

- We need 3 balanced meals at regular times, every 4 to 6 hours. We could include balanced snacks if our meals are spread over more than 4 hours.
- A healthy and balanced meal has 3 out of the 4 food groups from EWCFG, and a snack from 1 to 2 (including a source of carbohydrate).

[Slide 10, workbook page 6)- Portion planning tips:

- These strategies can help us to eat healthy portions of food and to balance our meals.

When you prepare you a meal, half of the plate should be vegetables, at least two kinds. One quarter of the plate should have low or medium-glycemic Index foods such as whole grain bread. Include one serving of protein such as lean meat. Have one glass of milk low fat and one piece of fruit. Sometimes our meals are not laid out on plates like the example here. If you are eating a meal from a bowl, or something like a stew or curry, you will have to think about how much of each food group is in each bowl.

- Imagine the same plate with half of it as rice and half as meat, what would the effect on blood sugar be after this meal? Now, what would the effect on blood sugar be if we have a quarter as grains, quarter as meat or alternative and half as vegetables?
- Therefore is really important to balance our meals by including vegetables, low or medium glycemic index foods and lean sources of protein. This will allow for a gradual digestion of carbohydrate and gradual release into our blood.

[Slide 11, page 7)- Handy portion guide

You can also use your hands to estimate appropriate portion size.

[Slide 12] Activity - allow 5 minutes.

Guess serving sizes of food - grapes, cheese, nuts, cereal. Have these foods on hand. Choose volunteers and ask people to choose what they believe one serving size of a certain food is. After they have done this, show the group what serving sizes actually are.

Setting goals for week 1

Explain to everyone: Setting a tangible goal can help you change your eating habits. It's easier to set a goal if you know where you're starting from. This week, we're going to concentrate on goals related to the recommended servings in the Food Guide. To help you, use the **diet record** that you did last week.

Hand out the results for everyone.

Have everyone take a look at their results. Ask them to think about the goals for meeting the serving recommendations for the 4 food groups based on their own results and the overall goals they have for themselves.

Ask everyone to write down their goals for in their **workbooks** (page 8).

[Slide 13] Encourage people to set achievable, realistic goals and SMART goals.

Specific: must answer the six W questions: What: What do I want to accomplish?; Why: Specific reasons, purpose or benefits of accomplishing the goal; Who: Who is involved?; Where: Identify a location; Which: Identify requirements and constraints.

Measurable: scale, will usually answer questions such as: How many?; How will I know when it is accomplished?

Achievable: think about how you can attain your goals. For example: Keep in mind the availability of the food, time for preparing meals, eating out.

Realistic: you have to be able and willing to work toward your goal every day. Set a realistic goal so you can attain it easily.

Timely: A goal should be grounded within a time frame. Your goals have a weekly timeframe. Keep track of everything you eat and drink each day. Before the next session, add up your servings for each group.

[Slide 14]- In the workbook: **For each day** of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below. Note that some of you may have had a high intake of **other foods** therefore this can also be part of your goals

Closing Session One

[Slide 15] Encourage everyone to track the number of servings from each food group. Thank participants for coming and sharing their experience. Remind them of the **date and time** for the next meeting. Allow participants to reflect, share issues, and answer questions. Also mention to them the next session that will be menu planning to help everyone follow Eating Well with Canada's Food Guide.

Give the participants the paper so they can write down what food they don't eat and what kind of food allergies they have. Because in the next sessions there will be food preparation and sampling sessions. Do this at the baseline meeting.

MEETING 2

Tags, menu plans, food demos and plate to show the plate method

Introduction [Slide 2]

Arrive early and greet the participants. Break the participants into groups of 5 to 6 participants. Tell them what the session today will cover. (Slide 2)

- Review goals and progress
- Introduce menu planning as a strategy

The first thing to do each week is to allow everyone to reflect on how they did the previous week vis a vis their goals, share their experiences, their successes and challenges. This self-reflection is very important to building self-efficacy. If you give them the menu plan first, it will distract them from the activity below.

[Slide 3, workbook page 1] Activity - allow 10 min

Let the participants discuss the questions on the first page of the workbook for week 2. Ask the participants to reflect on and report to the group the types of behaviours that helped them meet their goals. What specific types of things did they do? What did they have to give up? Who helped them? During the group discussion, listen to the answers and (only if necessary) raise questions to enhance discussion. Ask them to come up with the three most difficult challenges that they face and strategies to overcome these impediments and write these down in their workbooks. Discuss with them the challenges and strategies. If people had difficulty meeting goals, remember to reassure them that change behavior is not easy to achieve in a short time.

[Slide 4] *Introducing Menu Planning*

** Distribute the binders and menu plan for week one.*

- Explain to participants that the main purpose of today's session is to introduce menu planning as a way to help them achieve their dietary goals and to follow Eating Well with Canada's Food Guide. Explain that menu planning involves creating daily menus for an entire week.

[Workbook page 2] *Activity - allow 5 minutes*

Ask them to write what they think are some benefits and difficulties of planning their weekly menus in their workbook.

The Menu plan

[Slide 5] Describing the Menu Plan

Menu Plan for Albertans is a four-week menu plan that meets the serving recommendations outlined in Eating Well with Canada's Food Guide. It takes into account advice your dietitian or doctor may have given you about eating lots of fibre, spacing carbohydrates and lowering the amount of saturated fat and salt that you eat.

Let's take a look at the menus for the first day of the week.

Give people a few minutes to read through the menu. (5 min)

[Slide 6-7] Things you can talk about and help people with - You can adapt and make modifications to the menus according to your preferences and personal goals. There are two important tips when you want to substitute a recipe. First; the serving size should be the same. Second; when you exchange an ingredient, it should be from the same food group.

[Slide 8] Adjusting calories to meet your needs – if one of your goals is to lose weight, you may need to reduce the number of calories– here are some tips – talk about those, other ideas. (slide 8)

[Slide 9, Workbook page 2] – How to make the menu plan yours, to help you meet the main goal you wrote down at the beginning of last week. How to fit your lifestyle and your food preferences? Focus on the first day. What you would keep? What would you change to make it yours and achieve your goals?

Let the participants scan the menu plan. Spend the next 5 minutes brainstorming about how each of you could use this Menu Plan to help achieve your goals to follow Canada's Food Guide. Make sure everyone gets a turn to talk about their ideas. Write them down in the workbook. After this we will take a few minutes to share ideas amongst the group. (10 mins)

[Slide 10] Go through the basics of menu planning with participants

[Slide 11, workbook page 3 and 4]
Let the first group substitute the recipes "day one " in week one, and the second substitutes the recipes "day two" in week one. After they finish, share ideas from all the groups and make sure that substitutions are correct (10 mins)

[Slide 12-13]. Talk about menu planning tips Give out grocery lists.
Talk about benefits/challenges in preparing a grocery list. Brainstorm about how they can use this list.
Cooking and storing tips

[Slide 14] Talk about the importance of planning AHEAD of time. Discuss 2 scenarios 1) your afternoon meeting was longer than expected, you don't have lunch prepared, what to you eat? What are your options? 2) In the opposite scenario when you planned AHEAD of time you have good food available to eat right after your meeting.

Setting goals for week 2

Ask participants to write down their goals in the workbook. Remind them that their goals should be specific, measurable, achievable, realistic, and timely.

Closing the session two

Encourage everyone to track the number of servings from each food group. Thank participants for coming and sharing their experience. Remind participants of the date and time for the next meeting. Allow participants to ask, and answer their questions. Also mention to them the next session will use menu planning to prepare some healthy ready-to-eat meals. Also mention to them the next session that will be about modifying recipes to make them healthier and more suitable to their lifestyles

MEETING 3

Items needed for this week:

- **Tinfoil Plates, spoons, forks, measuring cups**
- **Ready-to-eat meals**
- **Menu plan week 2**

Introduction

Arrive early and greet the participants. Tell them what the session today will cover: today we will talk more about adjusting recipes according to needs, and how to eat prepare meals with appropriate serving sizes of each food group.

[Workbook page 1, slide 3] *Activity:*

Let the participants discuss the questions in the first page in week 3. Ask the participants to reflect on and report to the group the types of behaviours that helped them to increase their diet adherence. What specific types of things did they do? What did they have to give up? Who helped them? During the group discussion, listen to the answer and raise questions to enhance discussion. (10 mins)

Let each group share their experiences about using the Menu Plan and write down key points. (5 mins)

Did you have any difficulty finding menu items? Let each group share their experiences about the availability of ingredients in the Menu Plan. What kind of ingredients were hard to find or too costly. Then let each group write down challenges and solutions. (5 mins)

What would you do differently next week?

Let's figure out ways to make this Menu Plan your own. What are some of your reasons to change recipes and menu plans?

Introduce the menu plan for Week 2. Let everyone have a few minutes to look at it and suggest that before they use it they go through it and make the substitutions they prefer and make a grocery list.

[Slide 4 – 6] Talk to the participants about adapting the menu plan according to their needs, in more depth than last week.

<u>**[Workbook page 2]** Activity</u>
Ask participants to share examples of traditional recipes in their culture, and then discuss how these recipes contribute to serving sizes and food groups. (10 mins)

[Slides 7-9] Talk about adjusting recipes to make them healthier Involve participants in discussion on additional ways to make recipes healthier. (5 mins)

One way to help follow a menu plan is to have some healthy meals prepared in advance. We've had a professional cook prepare these 5 main courses from this week's recipes (these recipes will change):
1. Vegetarian Chili Chowder - week 2, day 3
2. Orange Chicken and Veggies with Rice - week 2, day 4
3. Fish Tacos with Avocado Salsa - week 2, day 5
4. Tangy Beef Stew- week 1, day 3
5. Zucchini Bran Muffin- week 2, day 7

We also have some whole-wheat rolls, vegetable sticks and cherry tomatoes available.

<u>**[Workbook page 3]** *Activity:*</u>

Let participants write down how to combine these foods into meals for themselves. Then let them take 5 tinfoil plates and prepare 5 "ready-to-go" meals. Let them use utensils so they can measure serving sizes.

Help participants to modify their meals. (15mins)

Setting goals for week 3

Ask participants to write down their goals in the workbook. Remind them that their goals should be specific, measurable, achievable, realistic, and timely.

Closing the Session 3

Encourage everyone to track the number of servings from each food groups. Thank participants for coming and sharing their experience. Remind participants of the date and time for the next meeting. Allow participants to ask, and answer their questions. Also mention that next week will be about label reading, choosing prepared foods, and restaurant eating.

MEETING 4

Materials:

- Menu plan week 3
- Nutritional information of restaurant
- Paper to write possible topics

Introduction

Arrive early and greet the participants. Tell them what the session today will cover: label reading, choosing prepared foods, and eating in restaurants

[Workbook page 1] *Activity:*

Let the participants discuss the questions on the first page in the workbook, week 4. How many days did you meet your goal during the past week? What worked & what did not work? Who helped them? During the group discussion, listen to the answer and raise questions to enhance discussion. (5 mins)

Give the participants the menu plan for the following week. Allow them a few minutes to look through it.

[Slide 4] Tell participants: this week we're going to start with label reading. Label reading is an important part of healthy eating because it helps you choose which foods are better for you. What do you look for on labels? That depends on what your healthy eating goals are, e.g. low calories, low fat, low sodium, high fibre, etc.

[Slide 4, workbook page 2] Go over the label reading fact sheet with participants.

[Slide 5-6] Choosing prepared foods: Buying prepared foods from the store can be helpful because it's less time consuming than making food from scratch, and can be just as healthy. It helps to know which options are the best, and which strategies can work. Label reading can come in very handy when doing this.

[Slide 7, workbook page 3] Activity:
Let's take a look at this label. How many available carbohydrates are there in this product? (total CHO – fibre). Using the %DV guide (<5% is a little, >15% is a lot), is this meal a good choice in terms of saturated and trans fat? Sodium? Fibre?

[Slide 8-9] Restaurant Eating: Restaurant eating is a normal part of any diet, and can be an important part of socializing. However, it is important to keep balance in mind. Restaurant food can be challenging because it's designed to be tasty and sell well, and even menu items which tout themselves as "healthy" may not be so healthy. Portion control also becomes a problem when eating out because restaurant portions are so unrealistically large.

[Slide 10] Go through slide 10 with participants. Discuss other tips with participants.

[Slide 11, workbook page 4] Activity:
Give out nutrition facts sheets for a restaurant (Montana's). Ask participants to each pick out one item that they would usually get at this restaurant from the menu, without looking at the nutrition information. Now ask them to take a look at nutrition info. Discuss reactions and opinions with participants. Now ask them to take another look at the menu with the nutrition info, and pick out an alternative menu item to their original which is healthier.

[Slide 12] Planning for delayed meals: present a scenario = your usual supper time is 6 pm, and you usually have an evening snack at 10 pm. You've been invited for supper, which won't be served until 8 pm. What do you do? Involve participants in discussion. A: snack at 6, dinner at 8. Maybe a snack later if the evening lasts long

[Slide 13, workbook page 8] Activity:
Sometimes, it's difficult to adhere to healthy foods in situations, for instance; weekend, eating out, work, holidays, travel and busy times. Let each group pick one of those occasions, and write down some strategies for finding/choosing healthy foods. Then, let them share their ideas. (15 mins)

Before everyone thinks about their goals for next week, take a few minutes to think about specific topics that you're interested in that we haven't addressed yet. Write them down on this piece of paper [hand out paper]. I will look at them before next week and see if there are a few topics that most of you are interested in, and incorporate them into our session next week, which is the last one until **DATE**

Setting goals for week 4

Ask participants to write down their goals in the workbook. Remained them that their goal should be specific, measurable, achievable, realistic, and timely.

Closing the Session 4

Encourage everyone to track the number of servings from each food groups. Thank participants for coming and sharing and remind participants of the date and time for the next meeting. Allow participants to ask, and answer their questions. Asked then if there specific topics that they're interested in that we haven't addressed yet. Also mention to them that at the next session they will participate in a cooking demonstration.

MEETING 5

Materials
Menu plan week 4
Foods for cooking demonstration

Notes

Participants should hand out the **<u>pedometer and workbook</u>** this session

<u>Date for booster session</u> should be established

Introduction

Arrive early and greet the participants.

[Slide 3, workbook page 2] *<u>Activity:</u>*

Let the participants discuss the questions in the first page in week 5.

[Slide 4, page 2-3] PLANNING TO STAY STEPPING FORWARD

Give some minutes to answer and reflect on these questions

[Page 4, slide 5] Introduce Chef Janice!

Let the chef take over and explain what she is doing.
Ideas – 5 ingredients, 3 different ways, showing how using herbs and spices can change the taste and adapt ingredients for different cultures

Closing the session 5
Before closing the session, cover any special topics that participants address last week. Thank participants for coming and sharing their experience. Collect the workbook from them. Remind them that in 4 weeks there will be a booster session that will include a visit to a local grocery store. You will phone them to remind them and tell them where to meet.

Appendix 2

Week 1 

The PANDA Program

Healthy Eating is important in treating diabetes. But many people say they find it hard to eat healthy or they don't know where to start. You are about to start the process, in bite-sized pieces. This program helps you begin to know how to eat healthy.

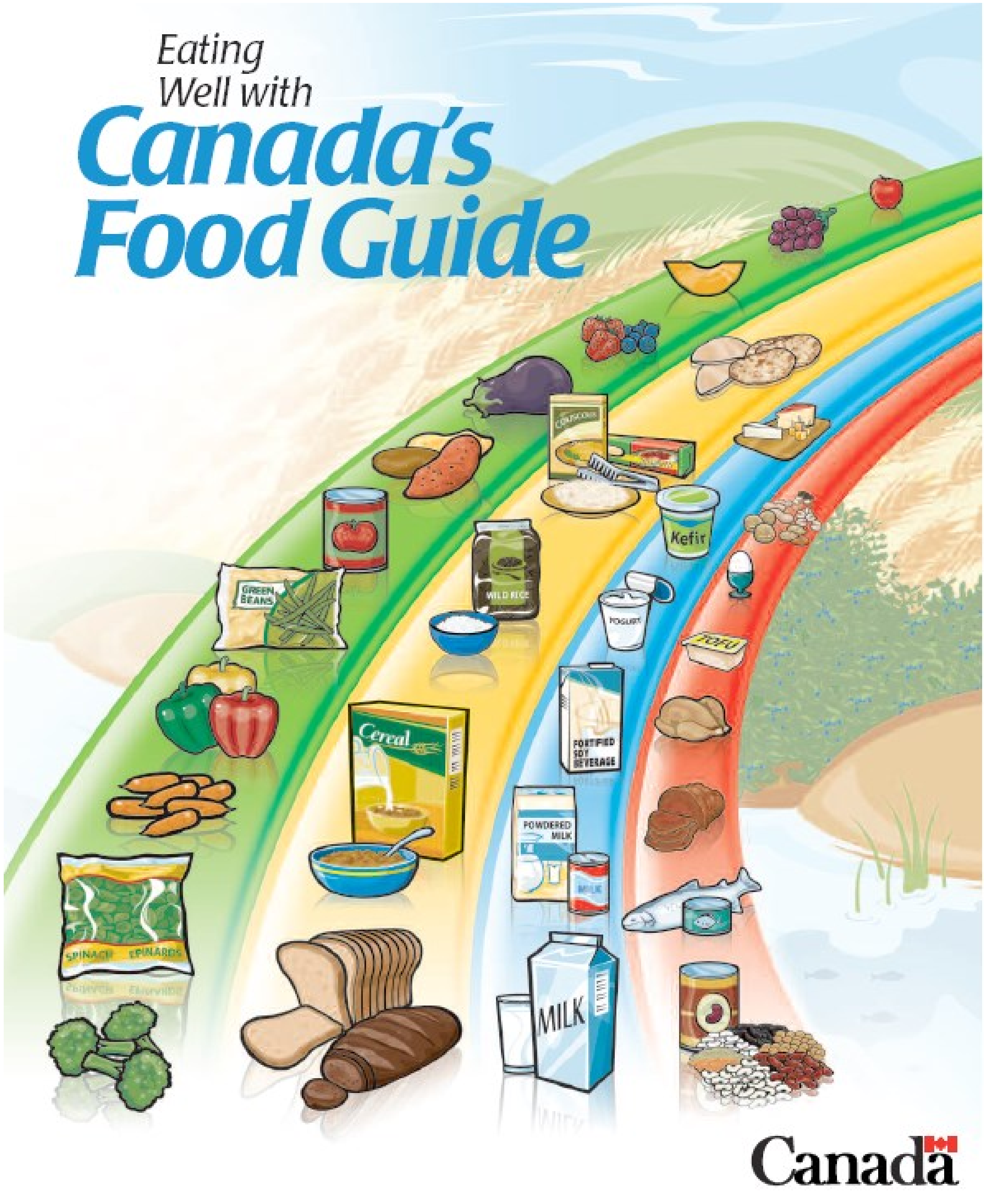
Something to think about

Changing eating habits can be hard to do. Let's begin by thinking about what you can get out of eating healthier, and what you may have to give up.

Gains for me	Losses for me	Plans (getting the most without giving up too much)
Gains for people around me	**Losses for people around me**	**Plans**

Canada's Guidelines for Healthy Eating

Canada's Food Guide will help you know how much food you need and what types of foods are better for you.



Name the food groups:

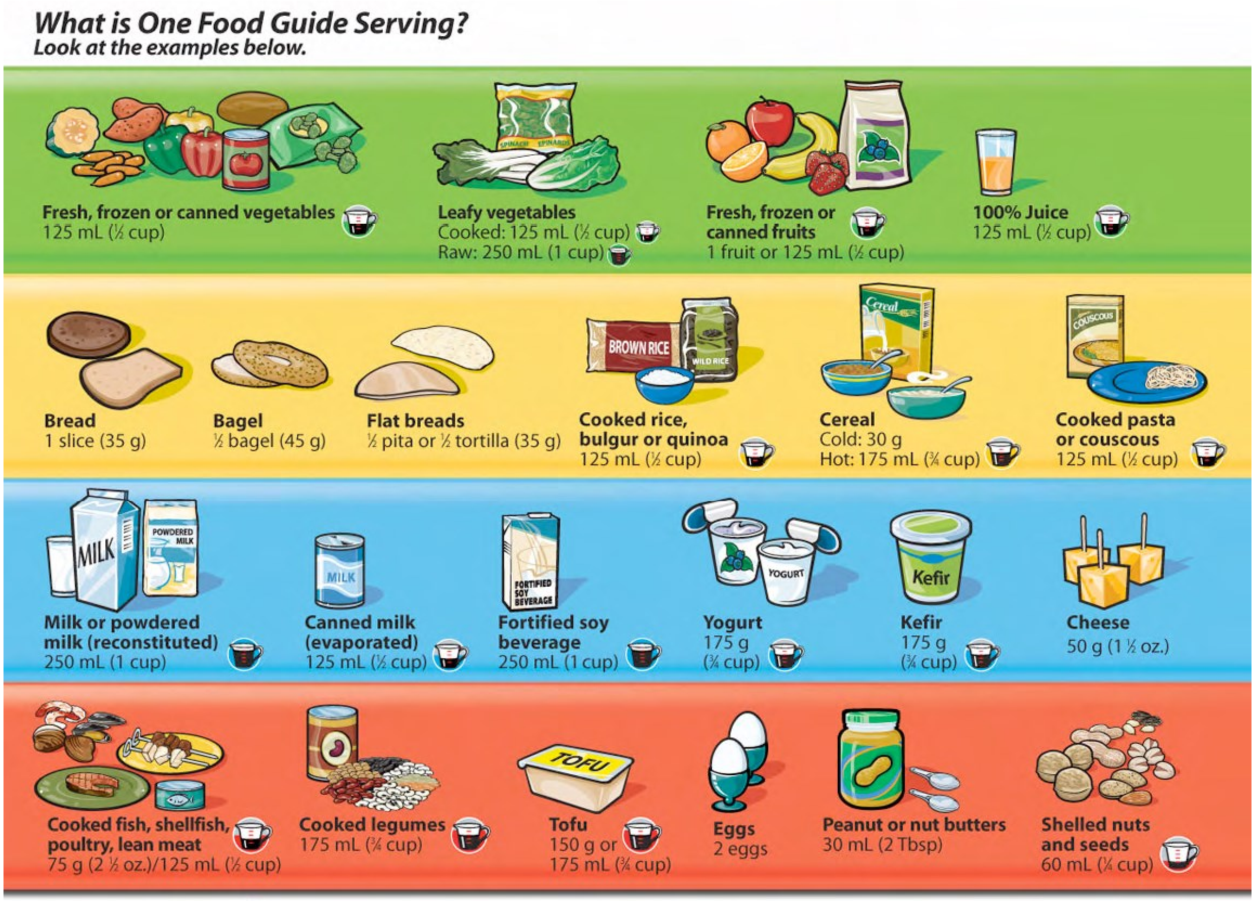
So, how much should I eat each day?
The Recommended Number of Food Guide Servings Chart shows how much food you need from each of the four food groups every day.

Recommended Number of Food Guide Servings per Day

	Children			Teens		Adults			
Age in Years	2-3	4-8	9-13	14-18		19-50		51+	
Sex	Girls and Boys			Females	Males	Females	Males	Females	Males
Vegetables and Fruit	4	5	6	7	8	7-8	8-10	7	7
Grain Products	3	4	6	6	7	6-7	8	6	7
Milk and Alternatives	2	2	3-4	3-4	3-4	2	2	3	3
Meat and Alternatives	1	1	1-2	2	3	2	3	2	3

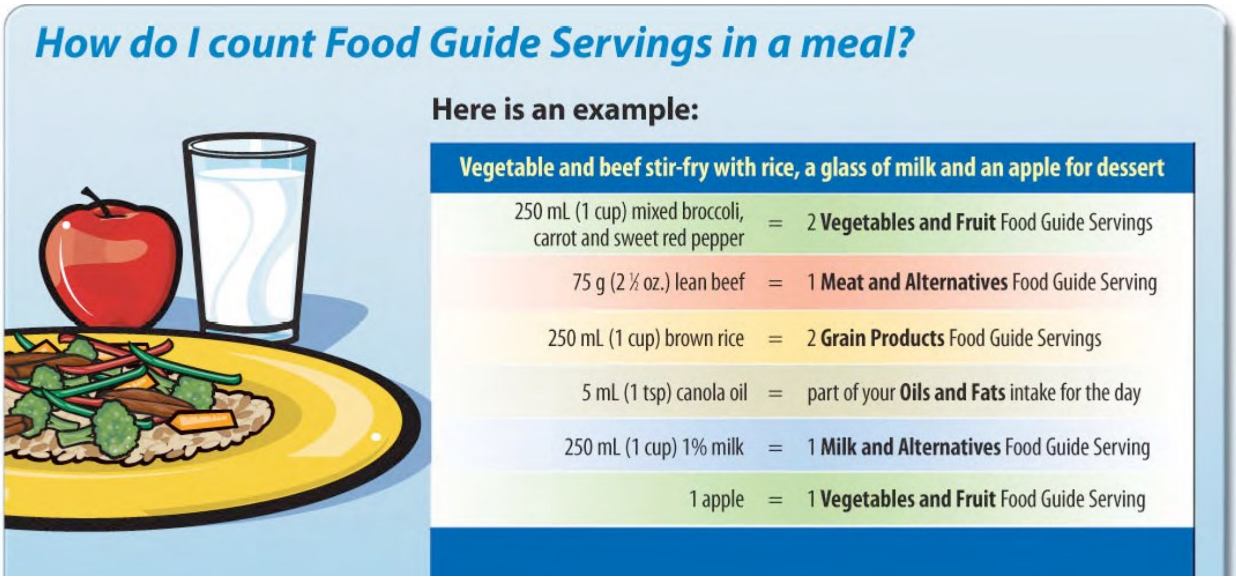
Circle the number of servings you need every day.

What do we know about Food Guide Servings?


What is One Food Guide Serving?
Look at the examples below.
Fresh, frozen or canned vegetables
125 mL (½ cup)
Leafy vegetables
Cooked: 125 mL (½ cup)
Raw: 250 mL (1 cup)
Fresh, frozen or canned fruits
1 fruit or 125 mL (½ cup)
100% Juice
125 mL (½ cup)
Bread
1 slice (35 g)
Bagel
½ bagel (45 g)
Flat breads
½ pita or ½ tortilla (35 g)
Cooked rice, bulgur or quinoa
125 mL (½ cup)
Cereal
Cold: 30 g
Hot: 175 mL (¾ cup)
Cooked pasta or couscous
125 mL (½ cup)
Milk or powdered milk (reconstituted)
250 mL (1 cup)
Canned milk (evaporated)
125 mL (½ cup)
Fortified soy beverage
250 mL (1 cup)
Yogurt
175 g
(¾ cup)
Kefir
175 g
(¾ cup)
Cheese
50 g (1 ½ oz.)
Cooked fish, shellfish, poultry, lean meat
75 g (2 ½ oz.)/125 mL (½ cup)
Cooked legumes
175 mL (¾ cup)
Tofu
150 g or
175 mL (¾ cup)
Eggs
2 eggs
Peanut or nut butters
30 mL (2 Tbsp)
Shelled nuts and seeds
60 mL (¼ cup)

How to count Food Guide Servings in a meal:

Meals typically consist of different foods from each food group. First you need to know what foods are in a meal, as well as how much of each food was used to prepare the meal.



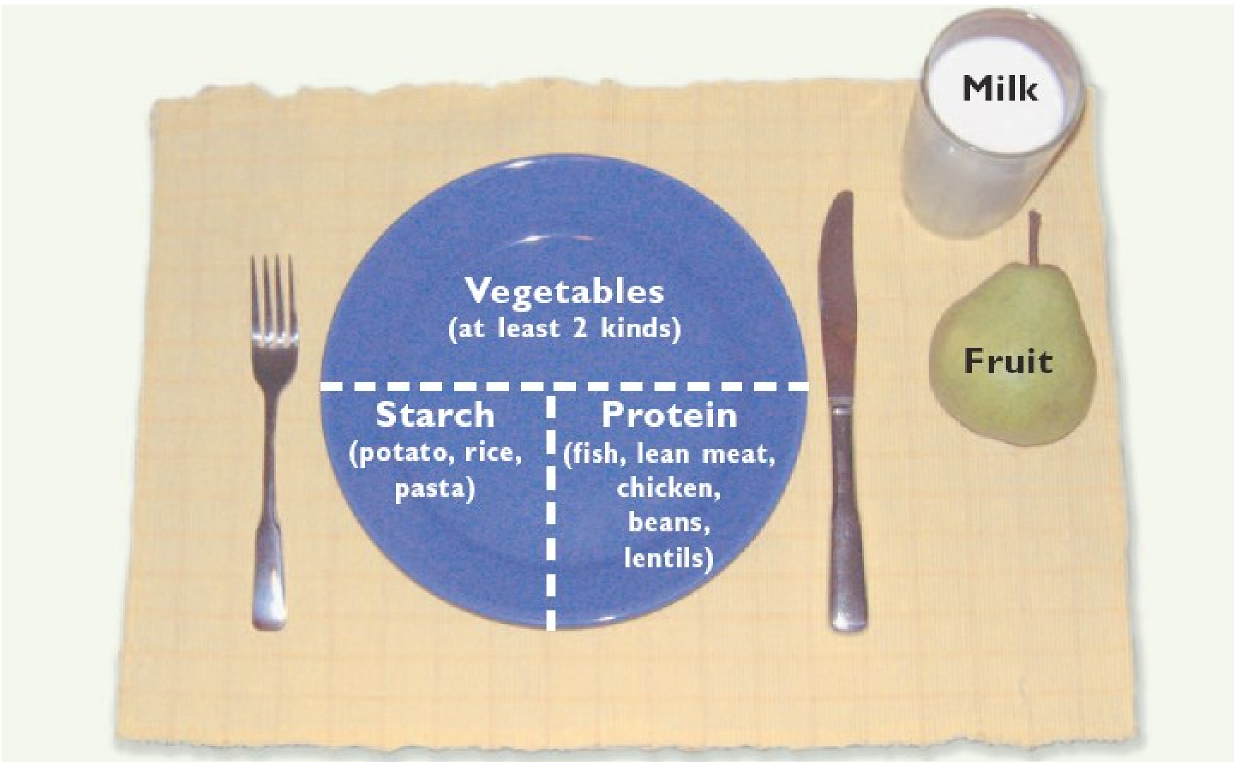
Let's practice!
First, write down all the ingredients used to make that meal and then identify in which food groups they belong. Next, compare the amounts of the main ingredients in a portion of the meal to the amounts that make up a Food Guide Serving in Canada's Food Guide.

Main ingredients used to make one portion of Beef Lo Mein	**Number of food guide servings**				
	Vegetables & fruits	**Grain products**	**Milk & alternatives**	**Meat & alternatives**	**Added oils & fats**
Chinese egg noodles 250 ml (1 cup) of cooked Noodles					
Sirloin steak strips 75 grams (2.5 oz) cooked					
Broccoli, red pepper, celery, onion 250 ml (1 cup) chopped vegetables					
Cashews 30 ml (2 Tbsp)					
Peanut oil 5 ml (1 tsp)					
Totals					

Portion Planning Tips

How do I measure what I eat?

When you have a meal, how do you know your meal is well balanced? There is a simple way that helps you eat a balanced diet.



Draw and Evaluate Your Meal!

Check List

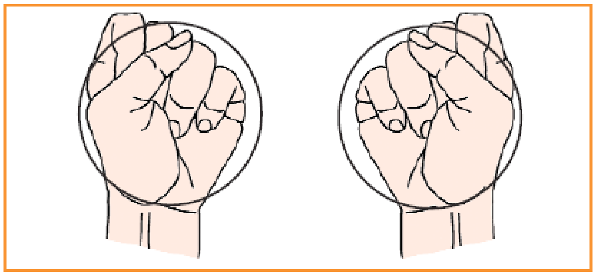
- Eat more vegetables. Does a half of your plate contain vegetables? (at least 2 kinds)
- Choose starchy foods such as whole grain breads and cereals, rice, noodles, or potatoes at every meal. Starchy foods are broken down into glucose that you body needs for energy. Does a quarter of your plate have starchy foods?
- Include fish, lean meat, low fat cheese, eggs, beans or lentils as part of your meal. Does your plate contain protein in the rest quarter?
- Have a glass of milk and a piece of fruit to complete your meal.

(Canadian Diabetes Association, Nov 2004)

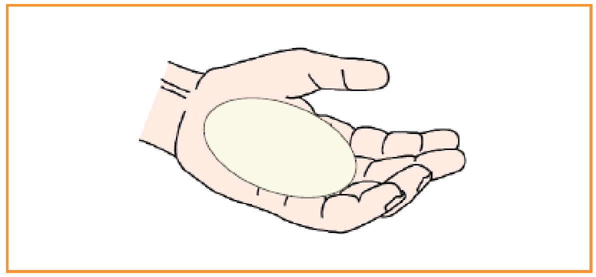
Handy Portion Guide

Your hands can be very useful in estimating appropriate portions. They're always with you, and they're always the same size!

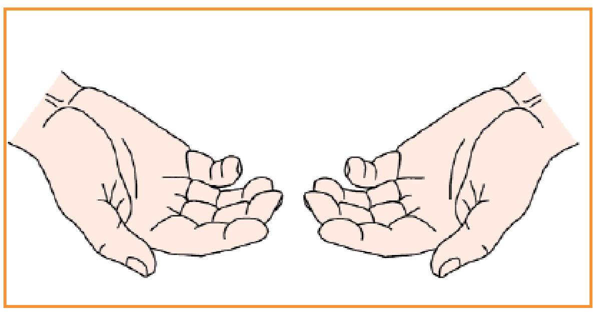
When planning a meal, use these portion sizes as a guide



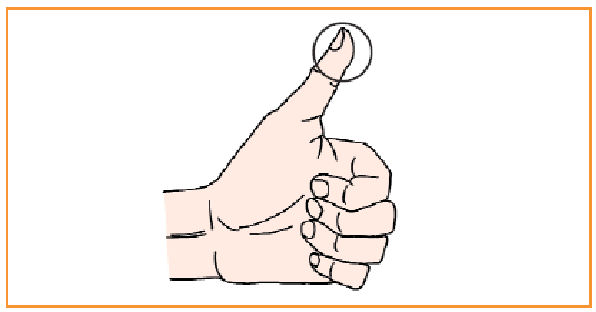
CARBOHYDRATES (grains and starches): Choose an amount the size of your 2 fists. For fruit, use 1 fist.



PROTEIN: Choose an amount the size of the palm of your hand and the thickness of your little finger.



VEGETABLES: Choose as much as you can hold in both hands. Choose low-carbohydrate vegetables (e.g. green or yellow beans, broccoli, lettuce).



FAT: Limit fat to an amount the size of the tip of your thumb.

(Canada Diabetes Association, Nov 2004)

SETTING GOALS - WEEK 1

My goals and checklist:
For each day of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below.

Following Canada's Food Guide

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Vegetables & Fruits							
Grain Products							
Milk & Alternatives							
Meat & Alternatives							

Get Bonus Marks!

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Eat at least 1 dark green vegetable	☐	☐	☐	☐	☐	☐	☐
Eat at least 1 orange vegetable	☐	☐	☐	☐	☐	☐	☐
Have a meat alternative	☐	☐	☐	☐	☐	☐	☐
Eat a serving of fish	☐	☐	☐	☐	☐	☐	☐
Satisfy your thirst with water	☐	☐	☐	☐	☐	☐	☐

My goal is to get a total score in a day of ____________________

Check how you do: Number of Checks for Each Day

Mon	Tues	Weds	Thurs	Fri	Sat	Sun

Ways to help me eat the right sized servings:

I will draw a picture and evaluate my meals every day ☐

I will use the Handy Portion Guide ☐

Other Goals:

____
____
____
____
____
____
____

How confident are you that you can stick to your daily goal over the next week?

Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1	2	3	4	5

How many days this week are you sure you will reach your goal?

0 1 2 3 4 5 6 7

Week 2 

HOW DID YOU DO LAST WEEK?

How many days did you meet your goal of following Canada's Food Guide during the past week?

WHAT WORKED?

On the days when you met your goal, what did you do?

WHAT DIDN'T WORK?

On the days when you didn't meet your goal, what did you do?

WHO HELPED?

Did you tell anyone about your goals?

Y N

Do you have anyone who could help to meet your goals?

Y N

How can your friends, co-workers, or family help you to meet your goals?

Challenges	Strategies

Menu Planning

Thinking ahead and planning can help you meet your goals!

List some benefits of planning your weekly menus

____

____

List some difficulties of planning your weekly menus.

____

____

Now let's look at the menu plan

Ways to use the menu plan:

Adapting the menu plan:

How the menu plan can help you meet your goals:

Recipe Substitution Activity

Meal	Ingredients per Serving	Canada's Food Guide Servings
Breakfast		
Morning Snack		
Lunch		
Afternoon Snack		
Dinner		
Evening Snack		
	Total Servings:	

Sample Menu Plan

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Morning Snack							
Lunch							
Afternoon Snack							
Dinner							
Evening Snack							
V/F Grains Meat/Alts Milk/Alts O/F	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□	□□□□□□□□□□ □□□□□□□□ □□□□ □□□□ □□□□□□□

SETTING GOALS - WEEK 2

My goals and checklist:
For each day of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below.

Following Canada's Food Guide

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Vegetables & Fruits							
Grain Products							
Milk & Alternatives							
Meat & Alternatives							

Get Bonus Marks!

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Eat at least 1 dark green vegetable	☐	☐	☐	☐	☐	☐	☐
Eat at least 1 orange vegetable	☐	☐	☐	☐	☐	☐	☐
Have a meat alternative	☐	☐	☐	☐	☐	☐	☐
Eat a serving of fish	☐	☐	☐	☐	☐	☐	☐
Satisfy your thirst with water	☐	☐	☐	☐	☐	☐	☐

My goal is to get a total score in a day of ____________________

Check how you do: Number of Checks for Each Day

Mon	Tues	Weds	Thurs	Fri	Sat	Sun

Ways to help me eat the right number and size of servings:

I will draw a picture and evaluate my meals every day. ☐

I will use Handy Portion Guide. ☐

I will use the Menu Plan. ☐

I will use the recipes for the Menu Plan. ☐

I will make a grocery list ☐

Other goals:

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How confident are you that you can stick to your daily goals over the next week?

Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1	2	3	4	5

How many days this week are you sure you will reach your goals?

0 1 2 3 4 5 6 7

Week 3 

HOW DID YOU DO LAST WEEK?

How many days did you meet your goal of following Canada's Food Guide during the past week?

WHAT WORKED?

On the days when you met your goal, what did you do?

WHAT DIDN'T WORK?

On the days when you didn't meet your goal, what did you do?

WHO HELPED?

Did you tell anyone about your goal?

Y N

Do you have anyone who could help to meet your goal?

Y N

How can your friends, co-workers, or family help you to meet your goal?

More Help with Menu Planning

Let's start by sharing your experiences using the Menu Plan.

What did you like about the Menu Plan?

What would you do differently next week?

Let's figure out ways to make this Menu Plan your own. What are some of your reasons to change recipes and menu plans?

Let's think about your cultural background. Are there foods that you like to eat that are special to your culture? Let's share a couple of examples of traditional recipes that you like to make and check to see how they contribute to servings from the four food groups.

We’ve had a professional cook prepare some recipes from this week’s menu.

Write down how you will combine these ingredients using the menu suggestions or your own ideas. First, think about the Menu Plan, what worked last week and what you would like to try to do this week. Think about how to incorporate these meals into the Menu Plan in the coming week. Write down how you want to combine these foods into meals for yourself. Think about the food groups as you plan your meals.

Meal 1:

Meal 2:

Meal 3:

Meal 4:

Meal 5:

Now, your task is to take 5 tinfoil plates and prepare 5 “ready-to-go” meals for yourself.

Now, make a plan about when you will eat each meal and what else you need to make a complete meal (think about beverages, for example). Add this to the list for each meal, above.

SETTING GOALS- WEEK 3

My goals and checklist:

For each day of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below.

Following Canada's Food Guide

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Vegetables & Fruits							
Grain Products							
Milk & Alternatives							
Meat & Alternatives							

Get Bonus Marks!

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Eat at least 1 dark green vegetable	☐	☐	☐	☐	☐	☐	☐
Eat at least 1 orange vegetable	☐	☐	☐	☐	☐	☐	☐
Have a meat alternative	☐	☐	☐	☐	☐	☐	☐
Eat a serving of fish	☐	☐	☐	☐	☐	☐	☐
Satisfy your thirst with water	☐	☐	☐	☐	☐	☐	☐

My goal is to get a total score in a day of ______________________

Check how you do: Number of Checks for Each Day

Mon	Tues	Weds	Thurs	Fri	Sat	Sun

Ways to help me eat the right number and size of servings:

- [ ] I will draw a picture and evaluate my meals every day.
- [ ] I will use Handy Portion Guide.
- [ ] I will use the Menu Plan.
- [ ] I will use the recipes for the Menu Plan.
- [ ] I will make a grocery list.
- [ ] I will use the pre-made meals.

Other goals:

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How confident are you that you can stick to your daily goals over the next week?

Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1	2	3	4	5

How many days this week are you sure you will reach your goals?

0 1 2 3 4 5 6 7

Week 4 

HOW DID YOU DO LAST WEEK?

How many days did you meet your goal of following Canada's Food Guide during the past week?

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WHAT WORKED?

On the days when you met your goal, what did you do?

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WHAT DIDN'T WORK?

On the days when you didn't meet your goal, what did you do?

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Using the Nutrition Facts Table: % Daily Value

How to CHOOSE

The Nutrition Facts table gives you information on calories and 13 core nutrients. Use the amount of food and the % Daily Value (% DV) to choose healthier food products.

Follow these three steps:

1 LOOK at the amount of food

Nutrition Facts are based on a specific amount of food (also known as the serving size). Compare this to the amount you actually eat.

2 READ the % DV

The % DV helps you see if a specific amount of food has a little or a lot of a nutrient.

5% DV or less is **a LITTLE**
15% DV or more is **a LOT**
} This applies to all nutrients.

Yogurt

Nutrition Facts
Per 3/4 cup (175 g)

Amount	% Daily Value
Calories 160	
Fat 2.5 g	4 %
Saturated 1.5 g + Trans 0 g	8 %
Cholesterol 10 mg	
Sodium 75 mg	3 %
Carbohydrate 25 g	8 %
Fibre 0 g	0 %
Sugars 24 g	
Protein 8 g	
Vitamin A 2 %	Vitamin C 0 %
Calcium 20 %	Iron 0 %

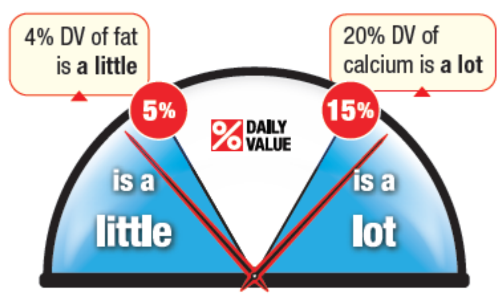
3 CHOOSE

Make a better choice for you. Here are some nutrients you may want…

less of
- Fat
- Saturated and trans fats
- Sodium

more of
- Fibre
- Vitamin A
- Calcium
- Iron

Here is an example of how to choose:
You are at the grocery store looking at yogurt. The small container (175 g) of yogurt you pick has **a little** fat (4% DV) and **a lot** of calcium (20% DV) – this is a better choice if you are trying to eat less fat and more calcium as part of a healthy lifestyle!



Également disponible en français sous le titre : Utilisez le tableau de la valeur nutritive : % de la valeur quotidienne.
HC Pub.: 100539
Cat.: H164-127/2011E-PDF
ISBN: 978-1-100-19881-1

Canada

How do you think label reading can help you at the grocery store?

Let's look at this label:

Nutrition Facts Valeur nutritive Per 1 bowl (300 g) / Pour 1 bol (300 g)	
Amount **Teneur**	**% Daily Value** **% valeur quotidienne**
Calories / Calories 440	
Fat / Lipides 19 g	**29** %
Saturated / Saturés 4 g + Trans / Trans 0.2 g	**21** %
Cholesterol / Cholestérol 35 mg	
Sodium / Sodium 860 mg	**36** %
Carbohydrate / Glucides 53 g	**18** %
Fibre / Fibres 4 g	**16** %
Sugars / Sucres 6 g	
Protein / Protéines 15 g	
Vitamin A / Vitamine A	45 %
Vitamin C / Vitamine C	4 %
Calcium / Calcium	20 %
Iron / Fer	20 %

How many available carbohydrates are there in this product?

Is this meal a good choice in terms of saturated and trans fat?

Sodium?

Fibre?

Let’s look at a restaurant menu and its nutritional information. What would you normally choose? Is this a healthy choice? Is there an acceptable alternative to this item on the menu that is healthier?

Eating Away from Home: Tips for making healthy choices
More Healthy Dining Tips: Multicultural Cuisine

Mexican
- Choose baked or pan-seared entrées, including fajitas, enchiladas, and burritos filled with beans, chicken or seafood.
- Ask for your food to be topped with salsa or pico de gallo instead of cheese sauce or sour cream.
- Select Spanish rice and black beans as a tasty, low-fat side dish.
- If you order a taco salad, consider leaving the fried tortilla shell.

Italian
- Choose pasta dishes served with tomato-based sauces instead of cream or butter sauces.
- Choose minestrone soup for your entrée. This tomato-based soup is filled with beans, vegetables and pasta.
- Choose healthy toppings for your pizza, such as fresh vegetables and low-fat cheese, instead of pepperoni or sausage.

Chinese
- Limit the fried noodles.
- Order fewer dishes than there are people at the table. Chinese entrées are designed for sharing, not for one person.
- Start with soup to fill you up.
- Limit fried appetizers (egg rolls or pupu platters). Order your dumplings steamed, not fried.
- Choose steamed rice, instead of fried. Ask for brown rice if available.
- Limit menu items described as crispy, golden brown, or sweet-and-sour. These items are all deep-fried.
- Choose dishes rich in vegetables and consider ordering at least one vegetarian entrée.

Greek & Middle Eastern

*Some favorite ingredients like feta cheese and olives are high in sodium.

Choose more often	Choose less often
Appetizers with rice or eggplant	Meat-stuffed appetizers
Dolmas (rice mixture wrapped in grape leaves)	Fried calamari
Tzatziki (yogurt and	Babaganoosh (eggplant

cucumber appetizer) Hummus	appetizer)
Roast lamb; shish kabob; couscous or bulgur wheat with vegetables or chicken	Moussaka (lamb and beef casserole) and other creamy or cheesy entrees
Chicken pita sandwich	Gyro
Plaki (fish cooked in tomatoes, onions and garlic) Tabouli	Spanakopita (spinach pie with egg and cheese)
Fruit	Pastries like baklava

Vietnamese

Choose more often	Choose less often
Canh chua tom (spicy and sour shrimp soup)	Banh michien voitom (fried shrimp toast)
Goi cuon (fresh spring roll)	Cha gio (fried spring rolls)
Bo xa lui nuong (grilled beef with lemon grass in rice paper with vegetables)	Vit quay (roast duck)
Ca hap (steamed whole fish)	Heo xao chua ngot (sweet and sour pork)
Lychee fruit	Banh dua ca ra men (coconut flan with caramel)

Eating Away from Home: Tips for making healthy choices
Fast Food and Other Food Venues

Here are some more examples of healthy choices.

At the coffee shop or breakfast stop	
Choose More Often	**Choose Less Often**
Low fat whole grain muffin	Danish, doughnuts, croissant
Small oatmeal raisin cookie	Chocolate, chocolate chip cookies
Small whole grain bagel with light cream cheese, peanut butter, or lower fat cheese	Bagel with regular cream cheese
Poached egg or plain omelette with unbuttered whole grain toast	Fried egg, fried egg sandwich, bacon, sausage, cheese omelette, hash browns
Tea or coffee with milk	Tea or coffee with cream
Café latte, cappuccino made with lower fat milk or chocolate milk	Hot sweetened drinks made with cream
Yogourt parfait (yogourt/fruit cup)	Other quick treats
At the concession stand/vending machine	
Choose More Often	**Choose Less Often**
Baked tortilla chips	Potato Chips
Plain air popped popcorn	Artificially flavoured and coloured corn and cheese snacks
Dried fruit bars	Sweetened, fruit-flavoured roll-ups
Fig-bars, graham crackers	Cream-filled cookies, chocolate chip cookies, cupcakes
Water, unsweetened fruit 100% juice, milk (plain or chocolate)	Fruit flavoured drinks (punch, iced tea, cocktail, beverage, -ade), frozen/slushy drinks, energy drinks
Frozen yogourt, sherbet	Regular ice cream
Cut up vegetables and fruit	Fries, poutine

Think about your specific lifestyle. You've already been trying to set goals that are consistent with your lifestyle, but let's see if Menu Plans can help to reduce some challenges. First, make a list of the kinds of situations when it's difficult to choose healthy foods. Here are some ideas to get you started.

Weekends	Eating out	Work
Holidays	Travel	Busy times

Now, pick one of those occasions, and write down some strategies for finding and eating healthy foods, using the Menu Plan to help you.

SETTING GOALS - WEEK 4

My goals and checklist:
For each day of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below.

Following Canada's Food Guide

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Vegetables & Fruits							
Grain Products							
Milk & Alternatives							
Meat & Alternatives							

Get Bonus Marks!

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Eat at least 1 dark green vegetable	☐	☐	☐	☐	☐	☐	☐
Eat at least 1 orange vegetable	☐	☐	☐	☐	☐	☐	☐
Have a meat alternative	☐	☐	☐	☐	☐	☐	☐
Eat a serving of fish	☐	☐	☐	☐	☐	☐	☐
Satisfy your thirst with water	☐	☐	☐	☐	☐	☐	☐

My goal is to get a total score in a day of ____________________

Check how you do: Number of Checks for Each Day

Mon	Tues	Weds	Thurs	Fri	Sat	Sun

Ways to help me eat the right sized serving:

I will draw a picture and evaluate my meals every day. ☐

I will use Handy Portion Guide. ☐

I will use the Menu Plan ☐

I will use the recipes for the Menu Plan ☐

I will use the ready-to-eat meals that I've prepared ☐

Other goals:

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How confident are you that you can stick to your daily goal over the next week?

Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1	2	3	4	5

How many days this week are you sure you will reach your goal?

0 1 2 3 4 5 6 7

Week 5 

HOW DID YOU DO LAST WEEK?

How many days did you meet your goal of following Canada’s Food Guide during the past week?

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WHAT WORKED?

On the days when you met your goal, what did you do?

WHAT DIDN’T WORK?

On the days when you didn’t meet your goal, what did you do?

WHO HELPED?

Did you tell anyone about your goal?
Y N
Do you have anyone who could help to meet your goal?
Y N
How can your friends, co-workers, or family help you to meet your goal?

I might take a step backward

Going back to unhealthy food choices might be considered a STEP backward. It could be hard to ALWAYS meet your goals lots of demands on your time, such as illness, work or other reasons.

How would you feel if you didn't reach your goal?

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PLANNING TO STAY STEPPING FORWARD

To be sure you are stepping forward, develop a plan to help you deal with 'high risk' situations which may prevent or discourage you from meeting your goals.

Have you ever had trouble making a healthy food choice? If you answer yes, list some of the reasons why.

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If you had trouble eating healthy, what helped you get back on track?

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PLANNING TO STAY STEPPING FORWARD

If you find you are having trouble stepping forward:

What will help you to start eating healthily again?

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Who can help you to continue to step forward when it becomes difficult?

Friends	Co-worker	Family	Pet

To help you to continue to step forward complete the table below.

Trouble Spots	Planning
Days when you think you won't be able to reach your goal	**Plans to overcome the trouble spots and maintain your goals**

A Few Specific Things to Think About

Everyone has different challenges to face in choosing healthy foods but this week we'll discuss a few things that many people have told us are challenges for them. We've invited a Chef to help cook up a meal that addresses these challenges.

Example: the Chef will cook a meal that utilizes herbs and spices to season food in place of salt; incorporates meat alternatives; lowers fat content – depending on issues identified as particularly problematic by the participants. The Chef will also talk a little bit about local foods – in the context of accessibility, availability and acceptability. The meeting will conclude with everyone sampling the food that has been prepared. Also, the Chef can participate in a discussion about how to choose healthy meals when dining in restaurants, low-cost ingredients, etc.

Try Alberta foods in your meal!

<u>Vegetables and Fruit</u>

	One Food Guide Serving
Butternut Squash	125 ml, 1/2 cup
Carrots	125 ml, 1/2, 1 large
Parsnips	125 ml, 1/2 cup - cooked
Tomatoes	125 ml, 1/2 cup
Spinach	250 ml, 1 cup - raw
Green beans	125 ml, 1/2 cup
Beets	125 ml, 1/2 cup
Cabbage	250 ml, 1cup
Cucumbers	125 ml, 1/2 cup
Lettuce	250 ml, 1 cup - raw
Zucchini	125 ml, 1/2 cup
Corn	125 ml, 1/2 cup, 1 ear
Strawberries	125 ml, 1/2 cup
Raspberries	125 ml, 1/2 cup
Saskatoon Berries	125 ml, 1/2 cup
Rhubarb	125 ml, 1/2 cup

<u>Grain Products</u>

Crops (Produce cereals, bread produces and flours)

Wheat
Oats
Rye
Durum
Triticale (hybrid of wheat and rye)

Cereal-cold	30g
Cereal-hot (cooked)	150 g, 175 ml, 3/4 cup
Bread	1 slice, 35g

<u>Milk and Alternatives</u>

Milk	250 ml, 1 cup
Cheese	50g, 1 1/2 oz.
Yogurt	175 ml, 3/4 cup

<u>Meat and Alternatives</u>

100 % Alberta beef	75g (2 1/2 oz.), 125 ml, 1/2 cup
100 % Alberta bison	75g (2 1/2 oz.), 125 ml, 1/2 cup
100 % Alberta pork	75g (2 1/2 oz.), 125 ml, 1/2 cup
Chicken	75g (2 1/2 oz.), 125 ml, 1/2 cup
Turkey	75g (2 1/2 oz.), 125 ml, 1/2 cup

Wild Game
(Deer, Moose, Rabbit, Lamb, Elk, Duck)
75g (2 1/2 oz.), 125ml, 1/2 cup

Pulses

Peas, Lentils, Beans, Chickpeas
175 ml, 3/4 cup - cooked

<u>Oil</u>

Oilseed crops (Produce the respective oils)
Flax, Canola
Seed Crops (Make seeds and oils)
Safflower, Sunflower, Canary seed

Oils	2-3 tbsp per day

SETTING GOALS - WEEK 5

My goals and checklist:
For each day of the next week, write in how many servings of each food group you plan to eat. During the next week, record the number of servings from each of the four food groups you eat every day. If you eat the recommended number of servings in each food group, check the boxes below.

Following Canada's Food Guide

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Vegetables & Fruits							
Grain Products							
Milk & Alternatives							
Meat & Alternatives							

Get Bonus Marks!

	Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Eat at least 1 dark green vegetable	☐	☐	☐	☐	☐	☐	☐
Eat at least 1 orange vegetable	☐	☐	☐	☐	☐	☐	☐
Have a meat alternative	☐	☐	☐	☐	☐	☐	☐
Eat a serving of fish	☐	☐	☐	☐	☐	☐	☐
Satisfy your thirst with water	☐	☐	☐	☐	☐	☐	☐

My goal is to get a total score in a day of ______________________

Check how you do: Number of Checks for Each Day

Mon	**Tues**	**Weds**	**Thurs**	**Fri**	**Sat**	**Sun**

Ways to help me eat the right sized serving:

I will draw a picture and evaluate my meals every day. ☐

I will use Handy Portion Guide. ☐

I will use the Menu Plan ☐

I will use the recipes for the Menu Plan ☐

I will use the ready-to-eat meals that I've prepared ☐

Other goals:
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How confident are you that you can stick to your daily goal over the next week?

Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1	2	3	4	5

How many days this week are you sure you will reach your goal?

0 1 2 3 4 5 6 7

Appendix 3

Grocery List Week

Food Group	Food Item	Quantity	Cost	✔
Vegetables & Fruit	Apples*			
	Oranges			
	Pears			
	Strawberries*			
	Bananas			
	Cantaloupe			
	Sweet bell peppers*			
	Celery*			
	Bok choy*			
	Romaine lettuce*			
	Broccoli*			
	Baby carrots*			
	Green onions*			
	Spinach*			
	Brussels sprouts*			
	Snow peas*			
	White mushrooms*			
	Zucchini*			
	Green beans*			
	Gingerroot			
	Spring mixed greens			
	Asparagus*			
	Potatoes*			
	Roma tomatoes*			
	Onions*			
	Cucumbers*			
	Garlic*			
	Frozen unsweetened mixed berries			
	Frozen unsweetened fruit mix			
	Frozen peas*			
	Apple juice (no sugar added)*			
	Canned fruit salad in water			
	Canned peaches in water			
	Canned tomatoes			
	Tomato paste			
	Pitted black olives			
	Canned artichoke hearts in water			

Grain Products	Whole wheat bread*			
	Raisin bread*			
	Whole wheat dinner roll*			
	Pumpernickel bread*			
	Whole wheat bagel*			
	Whole wheat English muffins*			
	Whole wheat pita*			
	Whole wheat tortilla (10 in.)			
	Rice cakes			
	Multi Grain Cheerios			
	Quick Cooking Barley* (see note 1)			
	Soda crackers			
	Melba toast			
	Graham wafers			
	Whole wheat penne pasta			
	Macaroni (or other small pasta)			
	Brown rice*			
	Wild rice*			
Milk & Alternatives	Low-fat mozzarella cheese (see note 2)			
	Low-fat cheddar cheese*			
	Low-fat cottage cheese			
	Low-fat cream cheese			
	Parmesan cheese*			
	Low-fat provolone cheese			
	Low-fat, no-sugar-added yogurt*			
	1% Milk*			
	Chapman's® vanilla frozen yogurt bars			
Meat & Alternatives	Firm tofu			
	Canned tuna (water-packed)			
	Egg*			
	Canned chickpeas*			
	Canned kidney beans*			
	Deli ham			
	Deli turkey* (see note 3)			
	Smoked turkey breast* (see note 3)			
	Canadian bacon			
	Fish fillet*			
	Lean pork tenderloin*			
	Sirloin beef steak*			
	Stewing beef*			
	Lean ground beef*			

	Boneless skinless chicken breast*			
	Hummus (optional; a recipe to prepare hummus is included)			
Pantry Items	Granola*			
	Rolled oats*			
	Granulated white sugar*			
	Brown sugar*			
	Whole wheat flour*			
	All-purpose flour*			
	Oat bran*			
	Wheat germ			
	Baking powder			
	Baking soda			
	Cornstarch			
	Ground flaxseed powder			
	Honey*			
	Maple syrup*			
	Vanilla extract			
	Molasses			
	Apple pie filling			
	Unsweetened applesauce*			
	Orange marmalade			
	Lentil puree/dry lentils			
	Margarine*			
	Canola oil*			
	Olive oil			
	Peanut butter			
	Raisins			
	Almonds			
	Dried cranberries*			
	Dried apricots			
	Dried figs			
	Sunflower seeds			
	Banana chips			
	Pecans			
	Walnuts			
	Popcorn kernels			
	Fat-free mayonnaise			
	Ketchup			
	Lemon juice			
	Dijon mustard			
	Low-fat balsamic vinaigrette			
	Fat-free Italian dressing			

	Low-fat ranch dressing			
	Vinegar			
	Low-sodium soy sauce			
	Worcestershire sauce			
	Teriyaki sauce			
	Low-sodium salsa			
	Sun-dried tomato pesto			
	Tomato pasta sauce			
	Roasted peppers in water			
	Low-sodium beef broth			
	Salt			
	Pepper			
	Cinnamon			
	Nutmeg			
	Dried rosemary*			
	Italian seasoning			
	Dried parsley*			
	Dried basil/tarragon*			
	Bay leaves			
	Ground allspice			
	Red pepper flakes			
	Apple cider			
	Coffee			
	Tea bags			

Stars indicate Alberta produced foods.

Note 1: Follow this link to find out where Quick Cooking Barley is available for purchase: http://www.progressivefoods.ca/wheretobuy.html.

Note 2: Instead of buying a variety of cheeses, pick your favorite ones! Most of them work well in different recipes.

Note 3: You can buy raw turkey breast instead of these items if you choose to prepare on your own.

Week 1, Day 1

Meal	Ingredients per Serving	Canada's Food Guide Servings
Breakfast Breakfast Parfait (see recipe, pg.25)	½ cup frozen berries ¼ cup low-fat granola ¾ cup low-fat yogurt ½ cup apple juice 1 cup coffee/tea 2 tbsp 1% milk (optional) 1 tsp sugar (optional)	*2 Vegetables and Fruit* *1 Grain Products* *1 Milk and Alternatives*
Morning Snack Oat Bran Applesauce Muffins with Roasted Almonds (see recipe, pg.26)	1 oat bran applesauce muffin 1 tsp margarine 1 tbsp roasted almonds	*1 Grain Products* *¼ Meat and Alternatives* *1 Oils and Fats*
Lunch Tuna Caesar Sandwich (see recipe, pg.27)	2.5 oz white tuna 1 tbsp artichoke hearts 1 tbsp onion 1 tbsp fat-free mayonnaise ¾ tbsp Parmesan cheese ¼ cup *each* cucumber and tomato ½ cup lettuce 2 slices whole wheat toast 1 cup 1% milk ½ cup canned peaches (in water)	*2 ½ Vegetables and Fruit* *2 Grain Products* *1 Meat and Alternatives* *1 Milk and Alternatives* *1 Oils and Fats*
Afternoon Snack Hummus & Crackers (see recipe, pg.28)	¼ cup hummus 6 Melba toast ¼ cup chopped tomatoes	*½ Vegetables and Fruit* *1 ½ Grain Products* *½ Meat and Alternatives*
Dinner Pork Tenderloin with Roasted Potatoes (see recipe, pg.29)	4 oz pork tenderloin ⅔ cup roasted potatoes ½ cup green beans 1 small whole grain dinner roll	*2 Vegetables and Fruit* *1 Grain Products* *1 ½ Meat & Alternatives* *½ Milk and Alternatives*

	1 tsp margarine ½ cup 1% milk	*1 Oils and Fats*
Evening Snack Cinnamon Raisin Toast	1 slice toasted raisin bread 1 tsp margarine 1 tsp cinnamon ½ cup 1% milk	*1 Grain Products* *1 Milk and Alternatives* *1 Oils and Fats*
	Total Servings:	***7 Vegetables and Fruit*** ***7 ½ Grain Products*** ***3 ¼ Meat and Alternatives*** ***3 ½ Milk and Alternatives*** ***4 Oils and Fats***

Good to Know

Nutrition facts of the day	*Adjusting today's menu*
Calories: 1848 Fat: 49 g Saturated fat: 13 g Carbohydrate: 262 g Fibre: 28 g Protein: 100 g	*To cut about 200 calories* • Have only ½ cup of yogurt at breakfast (saves 50 kcal) • Omit margarine at morning snack and dinner (saves 70 kcal) • Make an open-faced sandwich for lunch (saves 70 kcal) *To add about 200 calories* • Have 2 tbsp almonds at morning snack (adds 50 kcal) • Drink 1 cup of milk with your dinner (adds 50 kcal) • Have 2 slices of toast at evening snack (adds 100 kcal)

Breakfast Parfait

Serves 2

Ingredients

1½ cups	low-fat, low-sugar vanilla yogurt
½ cup	low-fat granola
1 cup	frozen mixed berries

Healthy tip:

Sprinkle in some ground flaxseed for fibre and a healthy oil boost. For an Albertan spin, choose strawberries, raspberries, cranberries

Quick tip:

When buying low-fat yogurt, choose one which contains 1% milk fat (M. F.) or less. The M. F. percentage is usually listed on the

Directions

1. Spoon ¾ cup yogurt into each glass. Top with granola and mixed berries. Enjoy!

➢ *Breakfast Parfait: Recipe by the PANDA Nutrition Team.*

Oat Bran Applesauce Muffins

Makes 19 muffins

Ingredients

1⅓ cups	whole wheat flour	325 mL
½ cup	oat bran	125 mL
½ cup	loosely packed brown sugar	125 mL
2 tsp	baking powder	10 mL
½ tsp	baking soda	2 mL
½ tsp	ground cinnamon	2 mL
½ tsp	ground nutmeg	2 mL
3 tbsp	vegetable oil	45 mL
1 cup	applesauce, unsweetened	250 mL
1	egg, beaten	1
¼ cup	finely chopped raisins	60 mL

Directions

1. Preheat oven to 375°F (180°C) and grease or paper-line two 12-cup muffin tins.
2. In a large bowl, combine flour, oat bran, brown sugar, baking powder, baking soda and spices.
3. In another bowl, stir together oil, applesauce and egg. Stir in raisins.
4. Add applesauce mixture to dry ingredients; stir just until moistened.

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5. Spoon batter into muffin tins. Bake in oven for 15 minutes. Cool 10 minutes before removing muffins from the pan.

Healthy tip:

Use a non-stick muffin pan or

Cook once, eat twice or even more:

Share with family and friends or

Tuna Caesar Sandwiches

Serves 4

Ingredients

2 cans	(5 oz *each*) white water-packed tuna, drained and flaked
¼ cup	marinated quartered artichoke hearts, drained and chopped
¼ cup	finely chopped onion
¼ cup	reduced-fat mayonnaise
3 tbsp	grated Parmesan cheese
2 tsp	lemon juice
1 tsp	Dijon mustard
8 slices	whole wheat bread, toasted
16 slices	cucumber
8 slices	tomato
2 cups	shredded lettuce

Directions

1. In a small bowl, combine the first seven ingredients. Spread over four slices of toast. Top with cucumber, tomato, lettuce and remaining toast.

- *Tuna Caesar Sandwiches: Recipe provided courtesy of Taste of Home magazine. Find more great recipes at www.tasteofhome.com.*

Healthy tip:

When buying canned artichoke hearts, choose the ones packed in water. The oil-

Quick tip:

If you are preparing a sandwich (or a wrap) ahead of time for lunch, pack ingredients

Five Minute Hummus

Serves 8 (serving size: ¼ cup)

Ingredients

1 can	(19 oz/540 mL) chickpeas, rinsed and drained	1
¼ cup	sundried tomato and herb salad dressing, low fat or calorie reduced	60 mL
2	garlic cloves	2
⅓ cup	water	75 mL

Directions

1. Place all ingredients into a food processor or blender. Blend, adding more water if necessary to achieve desired consistency.

2. Serve as a dip for pita bread, crackers or fresh vegetables.

Quick tip:

Hummus is super easy to make, but you can buy pre-made hummus at most

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➢ *Five Minute Hummus: This material is adapted with permission from copyrighted materials provided courtesy of Alberta Health.*

Pork Tenderloin with Roasted Potatoes

Serves 3

Ingredients

1	12-oz (375 g) pork tenderloin	1
2 tsp	orange marmalade	10 mL
2 tsp	Dijon mustard	10 mL
1 tsp	vegetable oil	5 mL
2 cups	potatoes, cut into 1-inch (2.5 cm) pieces	500 mL
1 tbsp	lemon juice	15 mL
1 tsp	crumbled dried rosemary	5 mL

Directions

1. Preheat oven to 375°F (180°C).
2. Pat pork tenderloin dry; place in center of a greased 11- by 7-inch baking dish.
3. In a small bowl, combine marmalade, mustard and ½ tsp (2 mL) of the oil; brush over pork.
4. In a medium bowl, toss potatoes with remaining oil; arrange around pork in baking dish. Sprinkle potatoes with lemon juice. Sprinkle pork and potatoes with rosemary. Bake in preheated oven for 40 to 45 minutes or until pork is just slightly pink at center and potatoes are tender. Cut pork into ½ inch (1 cm) slices before serving.

Healthy tip:

To boost your vitamin A intake, replace 1 cup white potatoes with sweet potatoes. For a fibre boost, leave the potatoes unpeeled.

Quick tip:

If you want to save some time, set aside 3 oz of pork tenderloin and use it for lunch in day 2 (see pg.30)

Appendix 4

	Variables	Change in HEI (score) per unit change in variable of interest	95% CI
Model 3*	Decrease in total calories (10 kcal)	2.71	-0. 42 to 5.83
	Decrease in total fat (1 g)	-0.021	-0.205 to 0.164
	Decrease saturated fat (1 g)	-0.111	-0.186 to -0.035
	Decrease total sugar (1 g)	-0.002	-0.016 to 0.012
	Decrease sodium intake (10 mg)	-0.60	-1.69 to 0.50
Model 4***	Decrease in total calories (10 kcal)	2.66	-0.60 to 5.91
	Decrease total fat (1 g)	-0.018	-0.216 to 0.181
	Decrease saturated fat (1 g)	-0.117	-0.195 to -0.039
	Decrease total sugar (1 g)	-0.002	-0.016 to 0.012
	Decrease sodium intake (10 mg)	-0.53	-1.68 to 0.62

Variables shown in bold text are significant predictors ($p<0.05$).
*unadjusted
** adjusted for age, gender, and baseline A1c