University of Alberta

Healthy Eating and Active Living: A Lifestyle Approach for Type 2 Diabetes Management

by

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

in

Nutrition and Metabolism

Department of Agricultural, Food & Nutritional Science

Edmonton, Alberta

Fall, 2007

Your file Votre référence
ISBN: 978-0-494-32988-7
Our file Notre référence
ISBN: 978-0-494-32988-7

Abstract:

The cornerstones of lifestyle management for Type 2 Diabetes (T2D) include diet and physical activity. This research examined the behavioural and metabolic effects of a series of lifestyle modification programs designed to help people with T2D implement recommendations for physical activity and diet as outlined by the current Clinical Practice Guidelines from the Canadian Diabetes Association. Programs were based on Social Cognitive Theory and incorporated principles of self-efficacy and social support. They were practical, easy-to-deliver and relatively inexpensive. Evidence was also gathered pertaining to the counseling strategies used by Registered Dietitians who participated in a workshop that was designed to provide knowledge and skills for promoting active living messages as an adjunct to their nutrition counseling practices.

This research has shown that people with T2D do not walk at a speed commonly accepted as moderately intense physical activity. However, they can walk faster when provided with the knowledge and skills. The increase in walking speed observed in this research led to improved fitness. This research has also shown that individuals can reduce the average daily Glycemic Index and daily Glycemic Load of their diet after participating in a lifestyle intervention. Finally, dietitians who are in an opportune position to promote physical activity, are interacting with physical activity experts in their communities and therefore may be in a pivotal position to aid in translating the knowledge gained from this research possibly through collaboration with other lifestyle modification specialists.

Acknowledgments:

Over the course of my program, numerous individuals and groups have provided words of support and encouragement, financial support, kindness and courage they include:

Dr. Rhonda Bell, my supervisor, for providing the opportunity to pursue academic excellence

My immediate and extended family who have supported my decision in so many different ways over the past 4 years

The numerous individuals since my arrival at the University of Alberta, particularly my supervisory committee, Dr Linda McCargar and Dr. Kim Raine who have provided mentorship and facilitated my progress

The many volunteers who participated in the work carried out. This research would not have been possible without their commitment and dedication

The various funding agencies including: the Heart & Stroke Foundation, the Danone Institute of Canada, the Canadian Institutes of Health Research Strategic Fellowship, Tomorrows Research Cardiovascular Health Professionals (TORCH) and the Department of Agricultural, Food and Nutritional Science

Michelle- my wife. My upbringing allowed me to see first hand the many sacrifices necessary to become a successful individual in academia. When we met, you had not experienced the good and bad times this journey presents. We are only beginning to enjoy the rewards for our dedication and sacrifice; thank-you from the bottom of my heart for supporting me in every way you have because without you this would never have been possible.

Table of Contents:

List of Tables:

List of Figures:

List of Abbreviations:

A_{1c}	Glycosylated hemoglobin
ACSM	American College of Sports Medicine
ADA	American Diabetes Association
AMP	Activity monitoring pod
AUC	Area under the curve
BG	Blood glucose
BMI	Body mass index
bpm	Beats per minute
CDA	Canadian Diabetes Association
CGPA	Canada's guide to physical activity
CFHE	Canada's food guide to healthy eating
CHD	Coronary heart disease
CPG	Clinical practice guidelines
CVD	Cardiovascular disease
DPP	Diabetes Prevention Program
FDPS	Finish Diabetes Prevention Study
FITT	Frequency, Intensity, Type and Time
FSP	First Step Program
FPG	Fasting plasma glucose
g	grams
GI	Glycemic index
GL	Glycemic load
hr	hour
HR	Hazard ratio
HR	Heart rate
HDL-C	High density lipoprotein- cholesterol
HGI	High glycemic index
IFG	Impaired fasting glucose
IGT	Impaired fasting glucose
IRAS	Insulin Resistance Atherosclerosis Study
LGI	Low glycemic index
LDL-C	Low density lipoprotein - cholesterol
METS	Metabolic equivalent of tasks
MNT	Medical nutrition therapy
n	number
min	minutes
mmol/L	milimole per litre
NHANES	National Health and Nutrition Examination Study
NIDDM	Non-insulin dependent diabetes mellitus
NWP	Non-workshop participants
OGTT	Oral glucose tolerance test
PA	Physical activity
PAI	Plasminogen activator inhibitor
PUP	Picking up the pace

RR	Relative risk
SD	Standard deviation
T2D	Type 2 diabetes
UKPDS	United Kingdom Prospective Diabetes Study
US	United States
RD	Registered Dietitian
VO_{2max}	Maximal Oxygen consumption
WHO	World Health Organization
WP	Workshop participants
2hPG	2 hour plasma glucose

List of Appendices:

Chapter 1 – Introduction

1.1.0 Overview:

According to both the Canadian and American Diabetes Associations, management of Type 2 diabetes (T2D) should include a healthy diet and physical activity immediately following diagnosis and in most cases prior to pharmacologic treatment (American Diabetes Association, Canadian Diabetes Association, 2003). Briefly, the current Clinical Practice Guidelines from the Canadian Diabetes Association (CDA) recommend that those with T2D follow a diet based on Canada's Food Guide for Healthy Eating (CFGHE) with specific advice to replace foods of a higher Glycemic Index (GI) with foods of a lower GI (CDA, 2003). Included in the CDA Clinical Practice Guidelines, are recommendations to "accumulate at least 150 minutes of moderate-intensity aerobic exercise each week" (CDA, 2003). These recommendations are largely based on evidence from meta-analytic data and large randomized trials among people who were at high risk for developing T2D. These large clinical trials were successful but relied on intensive lifestyle management strategies for preventing T2D among high risk individuals (Pan et al., 1999; Knowler et al., 2002; Tuomilehto et al., 2001). Thus, further research designing and evaluating lifestyle interventions that are less intensive and are germane to current and future clinical practice are needed.

It is generally accepted that when healthy eating and physical activity are incorporated into a total treatment, self-management regime, the overall metabolic health and quality of life of individuals with T2D can be expected to improve (American Diabetes Association, 2003; CDA, 2003). Indeed the preponderance of evidence indicates healthy nutrition and physical activity are essential T2D management strategies

(Nathan, 2002); however, an appropriate mixture of these management variables and how they are promoted in order to help individuals adopt positive dietary and physical activity behaviours that lead to clinical improvements remains to be determined. Thus, a greater understanding of management regimes that include both lifestyle components (diet and physical activity) that can be easily implemented and that are generally acceptable are necessary. Certainly, the work of Tudor-Locke et al., (2004) and our research group (Sian Hoe Cheong, 2005) have shown that relatively straightforward messages with a less resource intensive lifestyle program can lead to measurable dietary and physical activity behavior change. However, although the advice of "walking more" or "consuming more low-GI foods" were sufficient to spawn positive behaviour change, there was little shift in the clinical outcomes.

This program of research was initiated to gain a better understanding of the current strategies and individual behaviours necessary for positive lifestyle management among individuals with T2D. The goal was to evaluate the dietary and physical activity behaviours and the associated metabolic outcomes among individuals with T2D after participating in programs that incorporated aspects of the current lifestyle recommendations contained within the current CDA Clinical Practice Guidelines (CDA, 2003). The programmatic framework is theoretically based on the Social Cognitive Theory (Bandura et al., 1977); incorporating principles of self-efficacy and social support and is intended to be practical, easily-to-deliver, relatively inexpensive and one that might be easily translated into a clinical or community setting. The overarching theme and intent of this research program was to move away from an intensive management

system through the use of basic messages and simple feedback tools while using currently available resources to guide self-management.

1.2.0 Type 2 Diabetes (T2D) definition and diagnosis:

In the recent past, T2D has become an epidemic and has been attributed in part to the advancing age of the population and a Westernized lifestyle characterized by factors that include over nutrition and physical inactivity, which have principally contributed to an overweight and obese population (Nathan, 1993, 2002). The metabolic abnormality of T2D (also known as adult-onset diabetes and/or non-insulin dependent diabetes) is generally understood to be a result of impaired insulin action coupled with impaired insulin secretion (Rother, 2007; CDA, 2003). The resulting metabolic consequences are characterized by hyperglycemia.

The diagnosis of T2D is made following an oral glucose tolerance test (OGTT, a 75 g dose of glucose) whereby plasma glucose is measured in the fasting state and then 1 and 2 hours post glucose load. If an individual has a value of $\geq$11.1mmol/L one hour following the OGTT, diabetes is diagnosed (CDA, 2003). Similarly, the American Diabetes Association (ADA) uses the following criteria for the diagnosis of diabetes in non-pregnant persons: a plasma glucose concentration of more than 126 mg /deciliter (7.0 mmol/L) after a fast of at least eight hours, a plasma glucose level of more than 200 mg/dL (11.1 mmol/L) two hours after an oral glucose-tolerance test, or symptoms consistent with the presence of diabetes, such as polyuria and polydipsia, plus a plasma glucose level of more than 200 mg/dL (11.1 mmol/L), regardless of the time of day at which the measurement was obtained (note: the CDA diagnostic criteria are the same as the ADA - http://www.diabetes.ca/cpg2003/chapters.aspx). The fasting plasma glucose

level and results of the OGTT should be confirmed by retesting on another day (ADA, 1997, 2005).

1.2.1 Pathophysiology:

Individuals with T2D often also present with a cluster of risk factors that include: abdominal obesity, hypertension, dyslipidemia and insulin resistance (Liese et al., 2002). These clinical abnormalities were originally used to define the Metabolic Syndrome (Grundy, 2005; Reaven, 1993). Malik and colleagues (2004) have shown having only one of the individual metabolic abnormalities listed above may increase the risk of coronary heart disease (CHD) and cardiovascular disease (CVD) mortality among people with or without diabetes. However, having clinically defined Metabolic Syndrome more strongly predicts CHD, CVD, and total mortality than its individual components. Therefore, since individuals with T2D often have one or more of these abnormalities, any intervention that improves more than one of these components may also greatly reduce CVD mortality risk.

Diabetes may be due to relative insulin deficiency, usually in the face of insulin resistance, or due to a predominant secretory defect with insulin resistance (CDA, 2003) whereby the compensatory homeostatic mechanism of increased insulin secretion by the β-cells of the pancreas is progressively lost and exogenous insulin is required. To date, it is not known if this loss of β-cell function is due to autoimmune destruction, an acquired dysfunction or an inherited genetic predisposition for β-cell dysfunction (Bardsley & Want, 2004).

1.2.2 Epidemiology:

Current estimates in Canada, indicate that approximately 2 million people have been diagnosed with T2D, and conservative estimates suggest that by the end of the decade, nearly 1 million new cases of the disease will be diagnosed (CDA, http:// www.diabetes.ca/SectionAbout/prevalence.asp; Health Canada, 2003). The World Health Organization (WHO) has predicted that the global diabetes prevalence among adults will reach 6.4% by 2030, representing a 60% increase since 1995, and a 39% rise from 2000 to 2030 (King et al., 1998; Wild et al., 2004). Recent data from Ontario, confirms the increase predicted by the WHO but shows that from 1995 to 2005 there was in fact a 69% increase in the number of sex and age - adjusted incident cases of T2D in Canada indicating that previous world estimates may have been too conservative (Lipscombe and Hux, 2007). There is certainly little doubt that the current epidemiologic data indicates that the burden of T2D is continuing to grow and that effective programs and interventions for treatment and prevention are needed beyond our current medical model (Zimment et al., 2001).

1.3.0 Lifestyle modification and T2D:

Early evidence for positive lifestyle management of T2D was found over 3 decades ago. Hadden and colleagues (1975) found that good glycemic control could be achieved after six months of intensive dietary management with the aid of a dietitian among a group of individuals (n=57) with T2D. In this example, as with many intensive lifestyle programs, individualized meal planning based on repeated dietary assessment followed by one-on-one lifestyle counseling lead to the positive results. This study and others like it since then have lead to the appreciation that intensive lifestyle modification

is necessary for improved clinical outcomes, but since that time, obesity and overweight has continued to increase in the general population with a concomitant rise in the prevalence of T2D (Harris, 1991).

More recently, lifestyle modification was tested to determine whether improvements in dietary intake and physical activity could be used to achieve modest weight loss (7% over a 1 year period) and prevent the onset of T2D in people at high risk for this disease (Knowler et al., 2002). Studies including the United States Diabetes Prevention Program (DPP) and the Finnish Diabetes Prevention Study (DPS) were initiated to determine whether T2D risk could be reduced by lifestyle changes and/or by the use of antidiabetic medications in the pre-diabetic state (Knowler et al., 2002; Tuomilehto et al., 2001). The approach was multifaceted and focused on the most salient individual behaviours related to the common risk factors of overweight and obesity (i.e., over nutrition and physical inactivity). Because no studies had previously defined the most efficacious approach for T2D prevention, the intensive lifestyle management strategy that utilized lifestyle coaches, registered dietitians, nurses, behaviourists and physicians was compared to current pharmacologic regimes (Nathan et al., 2006). Indeed the intensive lifestyle approach has been shown to be effective (described in detail in section 1.3.1); however, it may not be practical for the current medical model due to lack of resources.

Since the completion of the DPP and the DPS, the benefits of Medical Nutrition Therapy (MNT) and physical activity for diabetes prevention has been acknowledged and imbedded into the Clinical Practice Guidelines. Whether these same approaches and management goals work to control T2D as well as reducing the risk of complications (i.e.

cardiovascular disease) associated with this disease remains to be determined. Further complicating this matter is the acknowledgement that the fulfillment of these lifestyle recommendations continues to be a challenge for most people with T2D and may be due, in part, to the fact that the translation of the evidence from these large clinical trials to current clinical practice (i.e. physician clinics and diabetes education centres) is not occurring (Hirsch, 2003). Hence, the objective of this thesis was to describe the dietary and physical activity behaviours among individuals with T2D and to develop and test a less intensive lifestyle management approach. The approach incorporated basic messages and uncomplicated feedback tools within a programmatic framework intended to serve as an alternate approach to the intensive individualized counseling approach that has been used to promote a lifestyle change for the management of T2D.

Thus, the following chapters describe a series of studies that examine programs to increase physical activity and promote healthy eating to people with T2D and to show that dietitians play an integral collaborative disease management role that strengthens and supports diabetes self-care through the promotion of both healthy eating and active living.

1.3.1 Intensive prevention and management of T2D:

A number of large multi-centre randomized controlled trials and meta-analytic data demonstrate the effectiveness of changes in lifestyle behaviours for preventing and managing T2D. These studies have provided convincing evidence that improving the lifestyle factors of diet and physical activity among individuals with IGT can dramatically reduce the incidence T2D.

The Da Qing IGT study was a large multi-centre study designed to determine whether changes in diet and physical activity reduced the progression to T2D among individuals with IGT (Pan et al., 1997). A total of 577 patients were randomized to one of 4 groups: diet, exercise, diet plus exercise or a control group. The dietary and physical activity goals were to allow 25-30% of total energy from fat and to increase physical activity (i.e. walking) by 30 min/day. Lifestyle counseling was provided through individual and group counseling. After a mean follow-up of 6 years, a 31% risk reduction with diet, a 46% risk reduction with exercise, and a 42% risk reduction with the combination of diet and exercise was demonstrated (Pan et al., 1997).

The DPP (Knowler et al., 2002) was a larger multi-centre randomized controlled trial which included approximately 3,200 individuals at high risk for developing T2D (i.e. they had impaired glucose tolerance or elevated fasting glucose at the time of recruitment). Participants in the DPP were randomly assigned to one of 4 groups: a standard lifestyle recommendation with metformin (850mg bid), standard lifestyle recommendation and placebo (no metformin), an intensive lifestyle modification program or troglitazone (400mg). The fourth group, a troglitazone treatment arm was discontinued early because of fears of hepatotoxicity. For those who were allocated to receive standard lifestyle recommendations (n=1,079), a one-on-one session lasting approximately 30 min was provided along with various handouts and pamphlets related to diet and physical activity. For those randomized to the intensive lifestyle modification arm (n=1,082) the goal of the program was weight loss of $\geq$7% from baseline which was to be achieved through behavioural modification goals of 150min/week of moderate intensity physical activity and a total daily fat intake that was < 25% of daily caloric

intake. They were to attend 16 core sessions over a 24 week period where individual counseling with lifestyle coaches (i.e. nurses and dietitians) was provided. A lifestyle coach was provided to each participant along with a toolbox of strategies (i.e. extrinsic reward system) in order to individualize the lifestyle management approach. During the 24 week intervention period, participants were expected to keep weekly food records that would be assessed by the research staff and used to guide dietary management. Supervised activity sessions were also provided, however participation was voluntary. These sessions were held in various centres in the community (i.e. churches, outdoors or fitness clubs) to allow easier access. Following the core education period, participants were contacted by the DPP study staff either by phone or mail at least every month and voluntary group sessions that incorporated various nutrition and physical activity topics along with behavioural and motivational strategies related to eating healthy and staying more active were provided. For those experiencing difficulty with the behavioural goals, voluntary activity sessions were provided and optional structured meal plans focusing on weight loss were made available. An individualized caloric goal was determined if weight reduction was unsuccessful.

Follow up data after 1 year showed that among the 1023 remaining participants, a 6.8 kg or 7% weight loss was achieved and after 3 years, among the 970 remaining participants, a 4.3 kg or 5 % weight loss was maintained. After an average follow-up of 2.8 years this study demonstrated a 58% risk reduction of developing diabetes in the group that received the intensive lifestyle counseling while there was a 31% risk reduction in the group that received Metformin alone (Knowler et al., 2002).

The Finnish Diabetes Prevention Study (DPS) was another large multi-centre randomized control trial examining the effect of intensive lifestyle management for the prevention of T2D (Tuomilehto et al., 2001). Following recruitment, 522 individuals with IGT were randomized to a control group or a lifestyle group. The control group was given general information about lifestyle and diabetes risk either individually or in one group session that lasted between 30 mins and 1 hour respectively. The authors provided little detail regarding the content of the sessions; however, they described some of the printed material that was provided. Generally, the lifestyle message was to reduce weight through increased physical activity and to attempt to make qualitative changes to the diet, importantly however, the counseling was not individualized. Those allocated to the intervention arm (n=265) were randomized to an intervention group who received individualized lifestyle counseling. Similar to the DPP, the main weight loss goal was >5% of baseline weight. The dietary and physical activity behavioural goals were a minimum of 30min/day of moderate to vigorous physical activity and to reduce fat intake to <30% of total daily energy intake (saturated fat <10%) and to aim for > 15g of dietary fibre/1000kcal. The DPS had a core learning component over a 6 month period. During the core period participants were asked to attend 7 individual lifestyle counseling sessions. Participants were asked to complete quarterly 3-day food records which subsequent dietary advice was based upon and an individual exercise prescription was provided with an accompanying membership at a fitness facility that was free of charge.

During the follow-up period participants were contacted by the study staff by mail or telephone to assess progress and provide general support. Group walking sessions were available on a voluntary basis along with lectures that included discussions with

experts in behaviour modification for diet and physical activity, grocery store tours and cooking classes. An optional very low calorie diet option was provided in a group session to help boost weight loss for an approximate 2 -5 week period (48 participants took part in this program). After a mean follow-up period of ~4 years, the cumulative incidence of diabetes was 11% in the intervention group and 23% in the control group. In other words, the data suggest the risk of developing diabetes was reduced by 58% ($p<0.001$) in the intervention group and this is in agreement with the results of the US-DPP. Once again, the observed reduction in the incidence of diabetes was associated with changes in lifestyle after participating in an intensive lifestyle modification program. These studies have certified the utility of diet and physical activity for preventing T2D; however, they have also raised important questions regarding the value of a highly structured and intensive lifestyle approach for the prevention and management of T2D.

The United Kingdom Prospective Diabetes Study (UKPDS) was a large multi-centre (n=23) study which recruited 5,102 patients with newly diagnosed T2D. Patients were followed for an average of 10 years to determine if intensive use of pharmacological therapy to lower BG might lead to improved clinical outcomes (i.e., reduced cardiovascular and microvascular complications) and whether the use of various sulfonylurea drugs, the biguanide drug metformin, or insulin had valuable therapeutic benefits or risks for people with newly diagnosed T2D (UKPDS, 1998). The main research question for the UKPDS was whether lowering blood glucose was beneficial. In the initial study design the four pharmacological mono-therapies described above were compared to a diet control group. The treatment goal in all the intensive pharmacotherapy groups was a fasting plasma glucose (FPG) <6.0 mmol/L. The

conventional diet control groups target was a FPG level <15 mmol/L. According to the study investigators these widely different treatment targets (<6 versus <15 mmol/L) were necessary to ensure separation of glycemic control. Interestingly, none of the oral pharmacological mono-therapies were capable of maintaining the intensive treatment goal (<6.0 mml/L) set out by the study investigators. As a result, combination therapy was used, whereby insulin or metformin were mixed with sulfonylureas, as well as crossing over patients into the alternate pharmacological treatment groups. Consequently, "intention-to-treat" comparisons had to be made between intensive therapy, which became all patients originally assigned to insulin and sulfonylurea drugs, and conventional therapy, which included all patients originally randomized to diet treatment.

The list below summarizes some of the important results from the UKPDS (adapted from ADA Position Statement, 1998):

- The complications common to T2D including retinopathy, nephropathy improved from lowering blood glucose levels with intensive therapy. Intensive therapy achieved a median HbA_{1c} of 7.0% compared with conventional therapy with a median HbA_{1c} of 7.9%. The overall microvascular complication rate was decreased by 25%. These results suggest, but do not prove, that hyperglycemia caused these complications because only associative data showed a continuous relationship between the risks of microvascular complications and glycemia, such that for every percentage point decrease in HbA_{1c} (e.g., 9 to 8%), there was a 35% reduction in the risk of complications.

- No significant effect of lowering blood glucose on cardiovascular complications was observed. A 16% reduction (which was not statistically significant, p = 0.052) in the risk of combined fatal or nonfatal myocardial infarction and sudden death was observed.
- Epidemiological analysis showed a continuous association between the risk of cardiovascular complications and glycemia, such that for every percentage point decrease in HbA_{1c} (e.g., 9 to 8%), there was a 25% reduction in diabetes-related deaths, a 7% reduction in all-cause mortality, and an 18% reduction in combined fatal and nonfatal myocardial infarction. No glycemic threshold for these complications above normal glucose levels was evident.
- Perhaps the most notable result from the UKPDS was that the risk of complications were significantly lowered even when HbA_{1c} levels were less than optimal (i.e. <8.0%).

In summary, data from the UKPDS showed an increase in blood glucose concentration regardless of treatment allocation over the course of study follow-up. The conventional treatment group achieved a 10-year median HbA_{1c} level of 7.9% and the group treated intensively with available glucose-lowering medications achieved a median HbA_{1c} level of 7.0%. Despite the fact that this evidence suggests maintaining a HbA_{1c} of <7% is difficult through conventional treatment with diet or medication, current guidelines for therapy rely heavily on this evidence. The evidence from the UKPDS also suggests that conventional treatment (i.e. diet and physical activity) could potentially be improved and thus presents an opportunity to search for novel and improved management approaches.

1.4.0 Physical activity and T2D:

Regular, moderate-intensity, physical activity, along with a healthy diet, are considered the frontline management strategies for T2D (CDA, 2003; Zinman et al., 2004; Sigal et al., 2006). Activities commonly regarded to be of moderate intensity include: bicycling, swimming, raking leaves, dancing and brisk walking (American College of Sports Medicine, 1998; Canada's Physical Activity Guide to Healthy Active Living).

Indeed, many national organizations have acknowledged the importance of physical activity for disease management. For example, the Canadian Diabetes Association (CDA, 2003) endorses physical activity for all people with diabetes since it can help them "achieve a variety of goals, including increased cardiorespiratory fitness, increased vigour, improved glycemic control, decreased insulin resistance, improved lipid profile, and maintenance of weight loss". Current Clinical Practice Guidelines from the CDA recommends that "people with type 2 diabetes should accumulate 150 minutes of moderate-intensity aerobic exercise each week, spread over at least 3 non-consecutive days of the week, or if willing, should be encouraged to accumulate four or more hours of exercising per week" (CDA, 2003). Similarly, in the United States (US), the recommendations for those in the general population and for those with T2D made by the US Surgeon General and the American Diabetes Association (ADA) echo similar public health recommendations that "all adults should accumulate 30 minutes or more of moderately intense physical activity (equivalent to brisk walking) on most, if not all, days of the week" (ADA, 2001; US Surgeon General, 1996). Dietary Guidelines for Americans (2005,www.Health.gov/dietaryguidelines) concur with the directives of these

other agencies ("engage in at least 30 min of moderately intense physical activity, above usual activity, at work or home on most days of the week"), but stress that activities of longer duration and greater intensity provide greater health benefit.

Currently, there are no population data describing the physical activity patterns of Canadian adults with T2D. Data from the third National Health and Nutrition Examination Survey (NHANES III) suggests that among United States adults with T2D, meeting public health recommendations for PA is uncommon (Nelson et al., 2002) Further, data from the United States in 2000 showed that more than half (54.6 %) of adults did not engage in physical activities of adequate frequency, duration and intensity during active periods (i.e., household, transportation and leisure-time activities) so as to meet public recommendations (Macera et al., 2000). Similarly, according to the Canadian Community Health Survey 2000/01, 56% of Canadian adults are insufficiently active to derive health benefits[1]. These data may portray a "best-case" scenario since 2 recent studies (Strath et al., 2005; Mathews et al., 2005) employing both self-report and objective measures of physical activity (accelerometers and heart rate monitors) suggest that less than 50% of Canadians are meeting current physical activity guidelines. Although current data does not specifically describe physical activity patterns among Canadians with T2D, it is unlikely that individuals with T2D exceed the rates reported in the general population, since T2D is strongly associated with a sedentary lifestyle (Knowler et al., 2002). Hence, strategies to increase physical activity that go beyond the provision of current public health messages are required.

Physical activity is a fundamental component of disease management for individuals with T2D. Evidence from large cohort studies suggest low cardiorespiratory

[1] http://www.cflri.ca/cflri/pa/surveys/2001survey/2001survey.html

fitness is a powerful and independent predictor of all-cause mortality and cardiac mortality among those with diabetes (Church et al., 2005; Church et al., 2004; Myers et al., 2002; Wei et al., 1999; Kohl et al., 1992) or without diabetes (Blair et al., 1996; Lee et al., 1999), even after controlling for traditional CVD risk factors such as age, hypercholesterolaemia, smoking, and hypertension. Regardless of the known benefits of physical activity, how best to help those with T2D to increase their physical activity and derive the inherent health benefits remains a fundamental unanswered question.

The CDA, ADA, Canada's Guide for Physical Activity (GPA), the US Surgeon General, and the Dietary Guidelines for Americans all suggest that moderately intense physically active for 30 min/day on 5-7 days/week will lead to health benefits (ADA, 2001; CDA, 2003; Health Canada, 1998; US Department of Health and Human Services, 1996). But what is "moderate intensity physical activity"? Ainsworth et al. (1993) describe moderate intensity physical activity in absolute terms as any activity that uses 3.5 – 7 kcal/min, or increases oxygen utilization by 3-6 fold compared to the resting state (equivalent to 3-6 metabolic equivalents (METS)). In a recent update of the Physical Activity recommendations for the American Diabetes Association, Sigal et al (2006) described moderately intense physical activity as 40-60% of VO_{2max} (~50-70% of maximum heart rate), and vigorous activity as those >60% of VO_{2max}. Although these definitions can be readily interpreted in exercise physiology labs with the help of specialists, they remain difficult to operationalize beyond the laboratory among people with little or no formal training in exercise physiology or a related discipline.

Public health messages and resources, such as Canada's Guide to Physical Activity (GPA, Health Canada, 1998), provide definitions of moderate intensity that are

intended to be readily interpretable by a broad, generally healthy, population. For example, walking at 4.8 – 7.2 km/h (3 – 4.5 mph) is considered to be moderate intensity activity. Other examples of moderate intensity activity listed in Canada's GPA include biking, raking leaves, or swimming. Canada's GPA suggests that people use subjective sensations such as "getting warmer" and "greater increase in breathing rate" (vs. light effort during which one would experience a "slight increase in breathing rate") to evaluate whether their activity is moderately intense. However, the extent to which people with T2D undertake activities at levels of intensity that would be considered moderate, in either absolute or relative terms, is not understood. Furthermore, there is no information that compares the speed and intensity of walking at a speed that is interpreted as "brisk", in free-living populations with or without T2D. Varying interpretations of the term "moderate intensity" may alter the health benefits derived from such physical activities among those with T2D. Thus, providing knowledge and skill around these concepts may facilitate the initiation and/or foster the maintenance of appropriate physical activity (or physical activity that meets the definition of brisk) among those with T2D.

1.4.1 Walking:

Epidemiological studies suggest that the most basic form of physical activity, walking, offers protection from developing T2D. Hu et al., in 1999, reported that among approximately 70,000 individuals from the Nurses Health Study Cohort, moderate-intensity physical activity such as walking provided measurable protection from developing diabetes during 8 years of follow-up. Calculated from self-reported physical activity questionnaires, participants were stratified into quintiles based on their total

weekly estimated energy expenditure. From this data, a dose-response trend for total physical activity emerged ($p<0.001$) whereby the relative risk of developing T2D was greatest for the least active quintile (RR=1.0) while the risk was lowest for the most active quintile (RR=0.74). A similar trend for physical activity intensity was observed, however, the dose response for physical activity of greater intensity was less predictive ($p= 0.01$). From these data, the authors concluded that activities of moderate intensity are perhaps of equal benefit to those of higher intensity.

All forms of moderately intense physical activity are recommended for improved health outcomes among people with T2D. However, walking appears to be the most popular (CDA, 2003; Tudor-Locke et al., 2002; Ford & Herman, 1995) and possibly most beneficial. Among adults with T2D, walking has been associated with reduced all-cause and CVD related mortality. Gregg et al. (2003), in their prospective cohort study of nearly 3000 US adults with T2D calculated that one death per year may be preventable for every 61 people who walked at least 2 h/wk. More recently, Smith and colleagues (2007) have suggested walking ≥1 mile/day offers strong protection from all-cause and non-CVD related mortality in older adults with diabetes. These data come from their 10 year follow-up study of approximately 350 individuals in the Rancho Bernardo Study, where they found that those who walked ≥1 mile per day were half as likely to die from all causes combined (hazard ratio =0.54; 95% confidence interval: 0.33, 0.88), and less than one-fifth as likely to die from non-CHD CVD (HR =0.19; 95% CI: 0.04, 0.86) compared to adults with diabetes who did not walk. These data suggest that walking more and/or at an intensity that is considered 'moderate' provides protection from developing diabetes and reduces the risk of developing cardiovascular disease.

1.4.2 Walking speed:

Previous research examining walking speed has been conducted primarily through observational techniques. These studies have shown people generally walk at speeds considered to be at or above moderate intensity. For example, Spelman et al., (1993), surreptitiously observed the self-selected walking pace of healthy individuals (n=29: 22 females, 7 males; age = 34.9 ± 8.6 yrs (mean ± SD) completing what was described as a typical exercise walk in a public park. The same individuals were invited to walk at their same self selected paced on a treadmill where it was determined that their group average walking speed was equal to 6.4 ± 0.7 km/hr and was equivalent to 52 % of VO_{2max} and 70 ± 9% of age predicted heart rate maximum.

In another study, Hardman et al., (1989) showed that sedentary women (age = 44.9 ± 7.9 yrs (mean ± SD)) increased their walking speed by 0.54 km/hr (6.19 ± 0.9 to 6.73 ± 1.3) following a 12 month physical activity program targeting brisk walking (note: the authors did not describe how walking speed was measured or if the increase was significantly different after 12 months).

Praise and colleagues visually observed the ambulatory characteristics among a group of older adults from walking on a one-half mile track. Among those who indicated that they walked briskly when exercising, men walked 5.72 ± 0.69 km/hr while women walked 5.54 ± 0.64 km/hr.

Murtagh et al., (2007) determined the waking speed of a group of individuals (n= 82; mean ±SD: age 47.9 ± 13.6, 43 females and 16 males) while passing over a predefined flat outdoor surface. Usual walking speed was covertly measured by a trained observer who calculated the time required to walk a predefined distance (18.56m).

Participants were intercepted and asked to walk briskly over that same distance. Of those who volunteered to demonstrate their interpretation of brisk walking pace (n = 52), their brisk walking speed was significantly greater than their self-selected and observed usual pace: 6.44 ± 0.7 versus 5.62 ± 0.6 km/hr respectively ($p \leq 0.001$).

These studies suggest that people self-select and identify usual and brisk walking speeds that agree with the definitions of moderate and vigorously intense physical activity. It is important to note, however, that these studies were carried out among individuals without disease and who were voluntarily participating in physical activity. With this in mind, the observed speeds form these studies may not agree with the ambulatory characteristics of unhealthy populations, particularly people with T2D.

1.4.3 Pedometery:

In their seminal work, Yamanouchi et al., (1995) set out to improve the insulin sensitivity of hospitalized individuals with T2D. A total of 24 obese individuals with T2D were randomly allocated to a diet and walking group or to a diet only group. The diet regime was based on caloric restriction from each individual's baseline caloric intake (range = 1,000 – 1,400 kcal/day). Individuals from each group were provided with a pedometer; however, the diet and exercise group was instructed to accumulate at least 10,000 steps/day, whereas the diet only group was encouraged to maintain their current level of activity and to record that amount. After an average follow-up of ~ 7.5 weeks the combined group lost significantly more weight versus the diet only group ($p<0.01$) and exhibited improved insulin sensitivity (based on a hyperinsulinemic, euglycemic clamp) ($p<0.001$). The most interesting and surprising result from this study was that the combined group nearly doubled the recommendation for daily steps, averaging 19,200 ±

2,100 steps/day whereas the diet only group accumulated 4,500 ± 290 steps/day on average.

Walker et al. (1999), found that after providing instructions to walk for at least 60 minutes/day on 5 days to postmenopausal women with T2D the participants (n=11) purposefully walked for approximately 4 hours/week. Improvements were observed in body weight ($p<0.05$), plasma lipid concentrations ($p<0.05$), glycemia measured as A_{1c} and fasting plasma glucose concentrations ($p<0.05$) and estimated VO_{2max} ($p<0.05$) following the intervention period.

Swartz and colleagues (2003) found that among a group of middle aged overweight women at high risk of developing T2D, a near doubling of their total daily steps/day (4972 to 9213;based on 7 day average) after 8 weeks led to improvements in 2-hr post-load glucose levels (from 9.4 ± 0.7 to 8.6 ± 0.7, $p < 0.001$), Area under the glucose curve ($AUC_{glucose}$) (from 1,138.6 ± 64.6 to 1,113.5 ± 70.1 $p = 0.025$, systolic (from 138 ± 3to 130 ± 2 mmHg, $p < 0.001$) and diastolic blood pressures (from 88 ± 1 to 83 ± 2 mmHg, $p=0.002$).

The contributions of Tudor-Locke and colleagues (2002, 2004) have provided considerable evidence that pedometer based programs are an acceptable means to help people with T2D increase their physical activity. During a pilot project the First Step Program (FSP) resulted in an increase of approximately 3000 steps/day above baseline (3-day average) and this produced a reduced waist girth ($p<0.01$) and improved systolic blood pressure ($p<0.05$) (Tudor-Locke et al., 2002). As a follow-up to the FSP pilot study, Tudor-Locke and associates completed a controlled evaluation of the FSP among a larger (n = 47) group of individuals with T2D. As observed in the pilot study, total daily

steps increased by ~ 3000 compared to baseline ($p = 0.025$) and similar to the data from the pilot study, waist circumference was significantly reduced.

In another more recent pedometer-based intervention, Araiza et al., (2006) randomized 30 individuals with T2D to either an active group (n=15) who were encouraged to accumulate 10,000 steps/day for 5 days/week group or a usual activity control group (n=15). After a 6 week intervention period, subjects in the active group significantly increased their average daily steps from 7220 ± 2792 to 10410 ± 4162 ($p=0.002$) while there was no increase in the control group. Glycemic control did not improve; however, high-density lipoprotein cholesterol and resting energy expenditure significantly increased in the active group ($p < 0.05$). Plasminogen activator inhibitor 1 (PAI-1) activity was significantly reduced among the active group relative to the control group ($p = 0.03$).

Collectively, the current body of evidence suggests that there are benefits of walking for individuals with T2D and for those at high risk of developing the disease. Indeed, walking can reduce the risk for developing T2D and it is a straightforward, acceptable and cost-effective form of physical activity and therefore an appropriate mode for achieving the recommendations from the CDA Clinical Practice Guidelines for physical activity. But because the current literature has shown limited evidence for improved glycemic control and/or cardiovascular outcomes in studies where the pace of walking was self-selected, further study is necessary to elucidate how best to improve these important clinical outcomes through this acceptable mode of physical activity.

1.4.4 Fitness

Current evidence indicates people with T2D have low fitness levels (Cuff et al., 2003; Ozdirenc et al., 2003; Arciero et al., 199). Boulé et al., (2003) in their meta-analysis, pooled data from 266 subjects (7 studies) with T2D and concluded the mean VO_{2max} was 22.4 ml/kg/min. These data suggest people with T2D may not be universally engaging in physical activity considered to be of moderate or high intensity. The external validity of these data from Boulé et al., (2003) must be considered carefully since many of the studies included in their analysis may not have included individuals with co-morbidities (i.e. cardiovascular disease or physical limitations such as neuropathy) which are common to this population. As a result, much of the pooled data may have come from more highly motivated individuals willing to participate in exercise studies. Thus, the estimated VO_{2max} may actually be an overestimate; as a result, activities > 60% of VO_{2max} (i.e. moderate intensity) which are often recommended could be considered difficult. Therefore the observed low level of fitness must be considered when recommending increased physical activity to people with T2D.

The cause of the low level of fitness among people with T2D is not fully understood. The T2D phenotype is generally characterized by excess adipose tissue and an insulin resistant state. The combination of overweight/obesity and insulin resistance poses many mechanical (movement) and metabolic barriers to engaging in physical activity particularly within skeletal muscle, a major site of glucose disposal (Jue et al., 1989). Numerous metabolic barriers that may impair individuals with T2D to increase or maintain their level of fitness at the skeletal muscle level have been described and they include: a reduced glycogen synthesis capacity, a reduced oxidative to glycolytic enzyme

ratio, an increased proportion of type II muscle fibres, a reduced capillary density and an increased intramuscular lipid content (Jue et al., 1989 ; Kelley et al., 1993; Simoneau et al., 1997; Simoneau et al., 1995; Nyholm et al., 1997; Lillioja et al., 1987; Kelly et al., 1991). Beyond the limitations describe above, Regenseiner et al., (1998) found that poor diffusion and utilization of oxygen at the level of skeletal muscle among a group of adult women with T2D. These limitations alone, or collectively, may help to define why the low level of fitness is observed in people with T2D.

The design of lifestyle programs for individuals with T2D presents a challenge because of their low level of fitness. Programs must begin with a recommendation to 'start slowly' by reducing daily sedentary time and progressing to more intense forms of physical activity.

1.5.0 Medical nutrition therapy and T2D:

Generally speaking, the goals of Medical Nutrition Therapy (MNT) for individuals with T2D are to improve and/or maintain the overall nutritional status, health, and quality of life while preventing the acute and long term complications of the disease such as cardiovascular disease (CVD) (ADA, 2002; CDA 2003). The CDA advocates and promotes the use of Canada's Food Guide to Healthy Eating (CFGHE, Health Canada, 1993) as an important resource that should be used to guide food choices (CDA, 2003). Canada's Food Guide to Healthy Eating provides a multi-dimensional yet straightforward guide for people to make healthy food choices. The guide incorporates fundamental nutrition principles which include:

(1) Enjoy a variety of foods
(2) Emphasize cereals, breads and other whole grain products as wells as vegetables and fruits

(3) Choose lower-fat dairy products, leaner meats and foods prepared with little or no fat
(4) Achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating
(5) Limit salt, alcohol and caffeine.

Besides the general nutrition principles listed above, the CDA provides more detailed, nutritional recommendations for individuals with T2D (CDA, 2003) which include: calorie intake from fat should be no greater than 30% of total daily energy requirements and no more than 10% of these should come from each saturated and polyunsaturated fats. Fish rich in omega-3 fatty acids should be consumed at least once weekly. Protein consumption should be 0.86g/kg/day, which is no different from that recommended for the general population. Daily energy intake from a variety of dietary carbohydrate sources such as grain products, vegetables, fruits, legumes, milk products and added sugars should range from 50 – 60%; however, intake of added sugar should not exceed 10% of the 50-60% of energy derived from carbohydrate. The amount and source of carbohydrate should also be considered and the CDA further recommends that low-GI foods should be consumed more often whenever possible in place of those with high GI in order to optimize blood glucose control.

1.6.0 The Glycemic Index (GI) overview and definition:

Carbohydrate intake is the nutrient known to influence post prandial glucose most significantly (Franz, 2004). However, not all dietary carbohydrates are equal from a chemical perspective and therefore they produce different glycemic responses to the normal physiologic processes of digestion, absorption and utilization (Englyst & Englyst, 2005). In order for dietary carbohydrate to be utilized by the body it must first be

digested, which itself is a complicated process (Cummings et al., 1997). It must then be absorbed and finally distributed and fully integrated with other physiological processes controlling glucose concentrations in circulating fluids and tissues. Thus, in order to better understand the effect dietary carbohydrate had on the glycemic response, Jenkins and colleagues (1981) systematically measured the glucose excursion rate of 62 commonly consumed foods whereby subjects consumed 50 g of carbohydrate from different food sources. Blood samples were collected at 0, 15, 30, 45, 60, 90 and 120mins and used to construct a blood glucose response curve. The area under this curve was then compared to the curve for a reference food, either glucose or white bread. The nominal food standards were lentils, white bread and glucose. They concluded that there were differences in the glycemic response to 50g of dietary carbohydrate from these 3 different sources over a 2 to 3 hour post prandial period and that consuming foods once considered to be negatively associated with blood glucose (i.e., increase blood glucose) based on their chemical analysis may not sufficiently predict the assumed physiological response. To determine the GI of dietary carbohydrate, the following calculation is generally used:

GI = Incremental blood glucose area of test carbohydrate/ Incremental blood glucose area of reference carbohydrate.

Currently, numerous sources listing the GI of commonly consumed carbohydrate foods can be found. Most notably and scientifically reputable is the International table of glycemic index and glycemic load values from Foster-Powell et al., (2002) and a complimentary web site www.glycemicindex.com. According to the CDA, foods

considered to have a high GI are greater than 70, medium between 55-69, and low if less than 55 (CDA, 2003).

1.6.1 The GI and nutritional management of T2D:

Evidence from prospective cohort studies as well as controlled clinical trials support the suggestion that the consumption of a diet with a low average daily GI score is associated with a reduced risk of developing T2D (Willet et al., 2002; Salmeron et al., 1997a; Salmeron et al., 1997b), improved glycemic control and reduced cardiovascular disease risk (McMillan-Price et al., 2007; Brand-Miller, 2002), thus it seems prudent to educate and encourage the consumption of foods with a low-GI as a nutritional management strategy for T2D.

Although some have suggested the evidence showing MNT as a means for management of T2D is inconclusive (Moore et al., 2004), the American Diabetes Association (ADA) Technical Review and Position Statement for "Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications" suggests otherwise, as it contains levels of evidence that range from Grade A to expert consensus (American Diabetes Association, 2002). Despite the Grade A recommendations based on the good evidence for MNT in their Technical Review and Position Statement, the ADA rate the current level of evidence for recommending a low-GI diet at Grade B, suggesting that there is little evidence to suggest low-GI diets improve long term glycemic control and that the effects on lipid profiles are still to be established (ADA, 2002). In contrast, the CDA supports and promotes the use of GI as a nutritional management strategy.

Since the suggestion by Jenkins in the 1980's that not all carbohydrates are digested and absorbed equally and therefore should be classified according to their glycemic response, various avenues of study linking GI to chronic disease have emerged in the areas of : obesity, cardiovascular disease, cancer and diabetes (Ludwig, 2002). In the subsequent years following the conception of the GI hypothesis by Jenkins, considerable debate over the utility of GI have emerged. For example, many have suggested that the GI concept is too complex and that it does not lend itself to be an acceptable method for disease management particularly in overweight and obese adults (Raben, 2002) because it may limit the food choices (Franz, et al. 2004; Beebe 1999;). By contrast, others suggest limiting food selection is not the objective of the GI, but rather it provides a guideline to select foods through a system of exchanges in order to improve the quality of the food choice (Brand-Miller et al., 1997; Brand-Miller, 1999; Katanas, 1999). For example, if an individual normally consumes white toast for breakfast (GI = 72) they would be encouraged to consume whole grain pumpernickel bread instead (GI = 50); however, few studies have been conducted to assess whether this is an efficacious and/or effective approach to nutrition therapy.

Some epidemiologic evidence suggests a diet with a high average daily GI score may increase the risk for developing diabetes. According to dietary information collected form the Health Professionals Follow-up study low dietary fiber intake and glycemic load were associated with increased risk of Non-insulin Dependent Diabetes Mellitus in men (Salmeron et al., 1997a). Similarly in the Nurses' Health Study (Salmeron et al., 1997b) the development of diabetes was greatest among those in the highest quintiles for GI and

Glycemic Load (GL)[2]compared to those in the lowest quintile. This association remained after adjustments were made for the traditional confounders: age, BMI, smoking, physical activity, family history of diabetes, alcohol and cereal fiber intake, and total energy intake. Conversely, data from the Iowa Women's Health Study (Meyer et al., 2000) and more recently from the Insulin Resistance Atherosclerosis Study (IRAS), no clear association was found between GI or GL and the risk of developing T2D (Mayer-Davis et al., 2006). Moreover, some have suggested simply measuring dietary GI does not fully characterize the effects carbohydrate containing foods have on blood glucose, in that GI may simply be a gauge of a more complex pattern of the diet, and that any beneficial effects from consuming a lower GI dietary pattern may be related to the consumption of a combination of numerous food choices (Schulz et al., 2005).

Controlled studies evaluating the impact of low versus high-GI on glycemia suggest a clear benefit. Brand-Miller and colleagues completed a (2003) meta-analysis of randomized controlled trials to determine whether low-GI diets, compared with conventional or high-GI diets, improved overall glycemic control in individuals with T2D. The study included 14 published randomized controlled investigations and included 356 individuals with diabetes. The mean difference between the high GI and the low GI diets was 32 with a range of 2 – 37. The pooled data suggested that a low-GI diet (mean = 65) versus a high-GI diet (mean = 83), on the white bread scale was associated with a statistically and clinically meaningful reduction in A_{1c} of 7.4 % which is equivalent to an A_{1c} reduction of 0.43%.

[2] Glycemic Load (GL) represents the combination of both the quality and quantity of carbohydrate into a single measure. GL = (Glycemic Index x the amount of available carbohydrate (g)) divided by 10.

Despite the disparate epidemiologic evidence, strong evidence from the majority of controlled intervention trials suggests consuming a low-GI diet is of clinical benefit. Thus, when considering an important message for MNT, promoting the consumption of more low-GI foods seems intuitive. However, aside from the controlled conditions of clinic or hospital based interventions, very few studies have been designed to evaluate or compare strategies that incorporate the concept of GI to improve the quality of dietary carbohydrate choices individuals with T2D make.

In a long term dietary intervention completed (Brand et al., 1991), 16 subjects with T2D were instructed by a dietitian on a weekly basis to follow a diet consisting of low-GI foods (e.g., porridge, pasta) vs. high GI foods (e.g., processed cereals, potatoes). Four-day weighed food records showed that consumption of the low-GI diet resulted in a GI score that was 15% lower than the high-GI diet (77 ± 3 vs. 91 ± 1). Glycemic control was improved on the low-GI diet compared with the high-GI diet ($p < 0.05$). After following the low-GI diet, the mean A_{1c} was 11% lower (7.0 ± 0.3%) than at the end of the high-GI diet (7.9 ± 0.5%), and the 8-h plasma glucose profile of these patients was lower (area under the curve above fasting 128 ±23 vs. 148 ± 22 mmol/h/L, mmol/L/hr respectively).

Fontivielle and colleagues (1992), randomly assigned 18 individuals with diabetes (both type 1 and 2) to consume a low-GI diet (38 ± 5) or a high-GI diet (64 ± 2) for 5 weeks. Subjects were then crossed over to the other diet group for another 5 weeks. When the participants followed the low-GI diet they had improved indicators of glycemic control (serum fructoseamine, fasting blood glucose and 2 hour plasma glucose) compared to when they were following the high-GI diet.

Frost et al., in 1994, reported that they provided diet counseling to consume a low-GI diet to a group with recently diagnosed T2D. After a 12 week period, serum fructoseamine decreased by approximately 0.6 mmol/L ($p<0.05$) and was significantly lower compared to a control group who were provided with standard dietary advice in the same outpatient counseling setting. Data collected from 3-day food diaries showed that the mean daily dietary GI was ~ 4 units lower for the group who received counseling and was significantly different from the control group ($p<0.01$).

Bouché et al., (2002) provided 11 overweight non-diabetic males with a list of the recommended daily intake of commonly consumed foods and a substitution list so that food exchanges within food groups could be made so as to reduce the GI of their diets. Over a 5 week period, carbohydrate containing foods with a GI <45 were to be selected and consumed, whereas foods with a GI >60 were to be consumed during a high - GI period. The intervention periods were separated by a 5-week washout period in a randomized crossover design. Based on 7-day dietary records, there were no differences for total daily energy (2,462 ± 75 vs. 2,204 ± 65 kcal for HGI vs. LGI), or macronutrients (carbohydrate: 42 ± 1 vs. 39 ± 1% of energy; protein: 18 ± 1 vs. 20 ± 1% of energy; fat: 37 ± 1 vs. 38 ± 1%) between the 2 periods. The main difference between the two periods was the calculated average daily GI (71.3 ± 1.3 vs. 41.0 ± 1.0% for HGI vs. LGI; $p < 0.0001$). An increase in the fiber content after the LGI period was also detected (19 ± 1 vs. 31 ± 2 g; $p < 0.0001$). Despite the observed differences in GI, there were no changes in body weight or fasting plasma glucose, insulin or fructoseamine concentrations over the 5 week dietary periods.

In a similar design to Bouché et al., (2002), Rizkalla and colleagues (2004) randomly allocated 12 men with T2D to 2 periods of 4 weeks of a low-GI or high-GI diet separated by a 4-week washout period, in a crossover design. During the 2 experimental periods participants were encouraged to maintain their normal daily routine and to consume ordinary food items. During the 4 week low- GI period, participants where instructed to consume carbohydrate items with a GI lower than 45, whereas foods with a GI greater than 60 were recommended during the high-GI period. To facilitate the food selection during the 4 week intervention periods a list of commonly consumed foods was provided. Foods included during the low-GI period included: pumpernickel, pasta, lentils, beans, chickpeas, and mung beans. Whole-meal bread, French baguettes, potatoes, and rice (white, cooked) were recommended for the high-GI dietary period. Prior to the first intervention period, all participants received individual diet counseling during a 15 day run-in period with a dietitian; at this time, a 3-day food recall was completed and showed that the average daily GI of the subjects' usual diets was 53 (the authors did not provide any measure of the variation in GI). Dietary intake was prescribed individually according to data obtained from dietary questionnaires (3-day recall technique). Total energy, carbohydrate, lipid, and protein intakes of the experimental diets were similar to the regular diet of each subject. The only change was the food choices to alter the GI of the two diets. At the end of each dietary period 7 day food records revealed no significant changes in macronutrient intake but a significant difference in the GI (71.3 ± 1.3 vs. 39.0 ± 1.0, $p < 0.0001$). Associated with the low GI period was a reduction in fasting plasma glucose (10.1 ± 0.8 to 9.19 ± 0.7 mmol/L, $p < 0.01$,) and A_{1c} (7.56 ± 0.36 to 7.17 ± 0.39 %, $p < 0.01$). Further, the low-GI period was

also associated with reduced fasting plasma total and LDL cholesterol (3.46 ± 0.44 to 2.63 ±0.26 mmol/L, $p < 0.01$), and free fatty acids (1.21 ± 0.19 to 1.01 ± 0.18 mmol/L, $p < 0.01$).

In another study, the GI values of meals consumed pre- and post counseling of 21 individuals with diabetes (both type 1 and 2) were calculated in a retrospective evaluation of the incorporation of low-GI carbohydrates into daily meal planning. Low-GI MNT counseling was associated with a 19% reduction in A_{1c} (mean drop of 1.5 %) and an 8% reduction in body weight (17 ± 3 lbs). Dietary analysis indicated a mean reduction of 15 points (25%) in the GI between the pre and post counseling periods (Burani et al, 2006).

Thirty-six subjects with T2D participated in a randomized, controlled, crossover study consisting of two separate 6-week periods with a 6-week washout period (Jimenez-Cruz et al., 2003). Following a 2 week run-in, and according to random group allocation, participants were provided a pamphlet describing low and high-GI foods in combination with dietary information about the amount of carbohydrate they should consume. Portion sizes guidelines were provided and were based on the Apple of Health illustration guideline which served to guide portion sizes through illustrations and helped to overcome language barriers (Bacardi-Gascon et al., 2002). Dietary analysis showed that while in the low-GI period compared to the high-GI period, participants consumed significantly fewer carbohydrates in the form of white-wheat bread, white long-grain rice, potatoes, high-GI fruits, and carrots, and consumed significantly more carbohydrates in the form of pinto beans, whole-meal wheat bread. A significantly lower A_{1c} was detected following the low- GI period compared with the high-GI period ($p < 0.008$).

Thus, many controlled clinical investigations provide evidence for the utility of the GI for improving clinical outcomes, particularly glycemic control, for individuals with T2D. However, fewer studies emphasizing the consumption of a low-GI among free-living individuals with T2D exist.

1.6.2 The GI and cardiovascular disease risk:

People with T2D have an elevated risk for developing CVD compared to the general population (Davidson, 2007). Epidemiologic evidence shows that consuming a low-GI diet may improve many traditional and nontraditional risk factors of CVD in adults with T2D. For example, cross sectional data from adults in the United Kingdom showed an inverse association between GI and high density lipoprotein – cholesterol (HDL-C) concentrations and dietary data from NHANES III complied by Ford and Liu (2001) strengthened the observations in the UK population when they also showed that higher dietary GI was associated with lower concentrations of HDL-C.

Short term and long term intervention studies examining GI and CVD risk among adults with T2D are somewhat limited. However, Wolever et al., (1992) showed a 7% ($p<0.001$) reduction in total serum cholesterol after consuming a low-GI versus a high-GI diet after 6 weeks among a group of individuals (n=6) with T2D. Jarvi and colleagues (1999) in their randomized crossover study compared the influence of consuming a low-GI diet to a high -GI diet for 24 days among 20 adults with T2D on several risk factors of CVD. When comparing the two diet periods, low density lipoprotein -cholesterol (LDL-C) was 8% ($p< 0.01$) lower after the low-GI diet than after the high-GI diet. The CVD risk factor plasminogen activator inhibitor (PAI-1) was reduced by 53% after the low GI period compared to the high-GI period.

The current evidence suggests consuming a low-GI diet may play a role in reducing the risk of developing CVD by improving the traditional and some of the non-traditional markers of risk; this is especially important because people with T2D have an elevated risk profile for CVD, thus a low-GI diet is an important risk management strategy for this population.

1.6.3 The GI and weight management:

A reduction in body weight is associated with a reduction in the risk of developing T2D among those with IGT (Knowler et al., 2002; Tuomilehto et al., 2001). Weight loss is associated with reduced blood pressure, reduced serum triglycerides and is also known to improve insulin sensitivity (Rippe et al., 1998). Short-term or acute feeding studies (i.e. single meal) have shown higher satiety and reduced voluntary consumption following low-GI meals, suggesting that this type of meal/diet could lead to reduced energy intake and therefore reduced obesity and overweight (Ludwig 2000). Since weight loss is an important target for individuals with T2D, it has been suggested consuming a low-GI diet may promote positive weight management (Anderson and Woodend, 2003).

Overall, these data suggest that counseling individuals with T2D to consume low-GI foods leads to moderate improvements in the metabolic profile of individuals with T2D. Moreover, these data suggest that by providing dietary advice and lists of appropriate foods, the consumption of a low GI diet is possible. Interestingly, many of the authors from these studies described above have concluded that minimal changes in dietary patterns are needed for favourable clinical outcomes. However, few of these studies provide sufficient detail describing the strategies or frameworks used to reduce

the GI. For example, there was no mention of behavioural theories or techniques to facilitate life-long behaviour modification. Strategies and techniques known to facilitate dietary modification include self-monitoring, goal setting, cognitive behavioral therapy, enhancing social support, and reinforcing healthy behaviors (Foryet et al., 1999). In short, disease management programs that incorporate techniques and strategies known to facilitate dietary behaviour change when combined with evidence from controlled trials indicating that changes in diet leads to improved glycemic control and reduced CVD risk need to be tested to determine their effectiveness as management strategies for free living individuals with T2D.

1.7.0 The role of Dietitians and lifestyle management of T2D:

Many individuals with T2D require guidance and reinforcement of the changes they make to establish and sustain changes in their lifestyle behaviours. From the time of diagnosis onward, health professionals such as dietitians need to be involved with patients for effective self-management training (Norris et al., 2001). Certainly it is generally understood that a dietitian's primary role with respect to diabetes self-management is to individualize the MNT component in the overall management of diabetes. Indeed, numerous controlled trials of nutrition therapy that have been led by dietitians have shown significant reductions in A_{1c} levels as well as other important metabolic outcomes including body weight and lipids, particularly among individuals with newly diagnosed T2D (Knowler et al., 2002; Kulkarni et al., 1998; Franz et al., 1995; UKPDS 7, 1990; Hadden et al., 1975).

The focus of MNT in patients with T2D is intended to address not only tight glycemic control but other metabolic abnormalities including body weight, lipids and

blood pressure (Kulkarni, 2006). A dietitian's expertise is generally sought to promote healthy eating and to target the aforementioned metabolic abnormalities; however, they may also be in a pivotal position to guide or reinforce active living messages as an adjunct to their nutrition counseling. Because physical activity has many physiologic and psychological benefits, combining healthy eating and active living messages has the potential to further improve many of the metabolic targets of people with T2D.

Knight et al (2006) in a recent systematic review of diabetes lifestyle management programs, found that among the 37 studies included in their review, almost 30% were lead by dietitians. Dietitians are trained in motivational interviewing and can effectively employ various behaviour techniques to facilitate dietary behaviour change among people with diabetes (Jackson et al., 2007). Behaviour modification for diet and physical activity often require similar educational and behavioural techniques (Baranowski, 2004). Because dietitians have experience in these types of techniques they are well positioned to facilitate behaviour modification that includes both healthy eating and active living.

Dietitians are not only positioned within a diabetes management team to provide specific direction for MNT but they can also promote physical activity with the aid of basic public health strategies and messages. Spidel at al. (2004) reported that dietitians (many of whom counselled individuals with diabetes) were very interested in incorporating active living messages into their nutrition counseling. McKenna et al (2004) found that dietitians were already promoting physical activity after surveying approximately 300 British dietitians. McKenna and colleagues reported that nearly 100% of these dietitians were promoting physical activity to their clients as an adjunct to nutrition therapy and the majority of the clients these dietitians counseled had diabetes.

Although there appears to be great interest for providing physical activity counseling to patients, many dietitians have indicated they require additional knowledge and training in physical activity (Spidel et al., 2004; George et al., 2006) possibly through specific programs and/or information and tools to promote physical activity to adults with chronic disease.

Thus it appears dietitians are willing to promote basic physical activity messages as an adjunct to MNT. Straightforward messages and feedback tools such as pedometers, along with guidance and monitoring, may be an effective means for dietitians to promote increased physical activity when counseling patients with T2D.

1.8.0 Summary

Managing T2D is a complex endeavor. Currently, the Clinical Practice Guidelines from the CDA provide recommendations for lifestyle management that include diet and physical activity. These recommendations are presented as general guidelines and are provided to patients immediately after they are diagnosed. This is a particularly stressful period for newly diagnosed individuals; thus, without basic resources and tools within an acceptable framework for free living individuals with T2D, successful management of their disease may be very difficult. Hence, there is an obvious need to develop and evaluate programs and strategies that are easy to initiate for those with diabetes but also that are easily implemented among those supporting disease management like dietitians, nurses and diabetes educators. Because diet and physical activity are considered the cornerstones of T2D management, gaining a better understanding of which health-related messages and what types of programs lead to positive behavioural and health outcomes in this clinical population are needed.

1.9.0 Aims and Objectives:

The overall aim of this research was to design, implement and evaluate an effective approach for lifestyle management that targeted diet (Glycemic Index) and physical activity (walking) to improve clinical outcomes in people with T2D. The individual objectives of each study were:

Study #1

To examine the ambulatory characteristics of free living overweight adults with T2D after completing a volume focused pedometer based walking program.

Study # 2

To examine the effects of a program designed to help people with T2D walk faster on their metabolic profile, specifically glycemia and cardiorespiratory fitness.

Study # 3

To compare changes in measures of glycemic control and cardiorespiratory fitness of people with T2D who received either a basic lifestyle modification program focusing on the quantity of daily physical activity and dietary carbohydrate versus an enhanced lifestyle program that emphasized both the daily quantity and quality of physical activity and dietary carbohydrate.

Study # 4

To examine the dietary patterns after a 6 month lifestyle intervention among overweight adults with T2D.

Study # 5

To examine if and how Registered Dietitians promote physical activity in daily practice one year after participating in a workshop targeting physical activity counseling as an adjunct to nutritional counseling.

1.10.0 Hypotheses:

We hypothesized that improving the quality of both diet (specifically GI) and physical activity (specifically walking) was necessary for improved health outcomes for people with T2D. The specific hypotheses of this research program were:

Study #1

People who have recently completed a volume-focused, pedometer-based lifestyle program will walk at a pace that is slower than recommended in the current Canadian Diabetes Association Clinical Practice Guidelines.

Study # 2

Among people with established T2D, an increased walking speed will result in an improved in glycemic control and cardiorespiratory fitness.

Study # 3

Adults with T2D who increase their normal walking speed by 10% for 30 mins for 3 days/week, will display greater cardiorespiratory fitness (resting heart rate) and better glycemic control (A_{1c}) compared to those who increase their total daily steps.

Study # 4

Adults with T2D who are encouraged to exchange higher GI foods with lower GI foods will have a lower A_{1c} compared to those who are encouraged to consume more low GI foods following a 12 lifestyle program.

Study # 5

One year after participating in an active living workshop that promoted strategies and resources to promote active living, Dietitians will be more likely to use these strategies resources compared to dietitians who did not attend the workshop.

1.11.0 Research program overview:

The two initial studies (Chapters 2 and 3) examined a convenience sample of individuals with T2D from the Edmonton region who were enrolled in a cross-sectional study (Chapter 2). The purpose of the first study was to gain a better understanding of the ambulatory characteristics of a subgroup of individuals who had participated in a walking program design to increase total daily steps (Johnson et al., 2005). Data from this study served in the design of a pilot intervention study to determine whether subjects with T2D could increase the intensity and the frequency of walking after 12 weeks with the use of basic monitoring and feedback tools (Johnson et al., 2006). A randomized clinical trial was completed to further test the observations from the pilot study and to add a dietary component to the walking component, therefore addressing the two pillars of lifestyle management (diet and physical activity) for T2D management. The results of the randomized trial are described in Chapter 4. Given the paucity of literature describing

the dietary patterns of people with T2D who have participated in a lifestyle intervention targeting GI, Chapter 5 was completed to gain further insight into the food choices made when comparing 2 different approaches for promoting the consumption a low-GI diet. The final study (Chapter 6) highlights the importance of translational research and sets the stage for further research in the area of health professionals promoting lifestyle changes. The information presented in Chapter 6 is from a cohort of registered dietitians from Alberta who participated in a workshop after which they successfully increased their knowledge and associated self-efficacy for promoting physical activity in their daily practice as an adjunct to dietary counseling (Spidel et al., 2004). One year following the workshop, dietitians were still promoting physical activity and appeared to be more aware of physical activity specialists in their community to whom they could refer their clients for further physical activity counseling compared with those who did not attend the workshop (Johnson et al., 2007). This chapter is important because dietitians are highly trained in the promotion of healthy eating and they are therefore well positioned to promote basic messages and to guide the use of appropriate messages and tools (i.e. pedometers) for increasing physical activity. For Chapters 3, 4 and 5, additional data was collected but was not included in the body of the thesis; in this regard, footnotes are provided in the aforementioned chapters listing the appropriate appendix to view these additional data.

In summary, the knowledge gained surrounding diet and physical activity over the course of this thesis provides a framework which may be translated by community and clinical dietitians to facilitate positive physical activity behaviour and highlights their role in the treatment of chronic disease.

1.12.0 References

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Chapter 2 - Measuring habitual walking speed of people with type 2 diabetes: are they meeting recommendations?[1]

2.1.0 Introduction:

Revised physical activity guidelines for individuals with Type 2 diabetes (T2D) recommend at least 150 minutes/ week of moderate intensity aerobic physical activity (40 – 60% of VO_{2max} or 50 – 70% of maximum heart rate) and/or 90 minutes/week of aerobic exercise (>60% of VO_{2max} or >70% of maximum heart rate) (Sigal et al., 2004). In a structured exercise program or in the laboratory setting, levels of physical activity can be closely monitored; however, self-directed walking is the most common and most acceptable form of physical activity (United States Department of Health and Human Services, 1996; Siegel et al., 1995) to people with T2D and little is known about self-paced walking speed (and therefore intensity). A walking speed of 4.0 km/hr is widely accepted as moderately intense physical activity (Ainsworth et al, 2000). Numerous studies examining the beneficial effects of physical activity for T2D exist (reviewed in: Sigal et al., 2004 & Boulé et al., 2004). Few, however, have directly measured walking speed.

Previous research demonstrated efficacy in increasing physical activity of participants using the First Step Program (FSP), a pedometer-based, self-paced walking program designed to help people with T2D increase their steps/day (Tudor-Locke et al., 2004, 2002). Despite the increase in physical activity, improvements in health outcomes were modest. In contrast, the implementation of the FSP in a worksite setting involving healthy adults resulted in significant reductions in weight, body mass index (BMI), waist

[1] A version of Chapter 2 has been published as a brief report: Johnson ST, McCargar LJ, Tudor-Locke C, Bell RC. Measuring habitual walking speed of people with type 2 diabetes: Are they meeting recommendations? **Diabetes Care** 28(6):1503-1504, 2005

girth and resting heart rate (Chan et al., 2004). We hypothesize that a slower walking speed in the people with T2D may contribute to the smaller improvements in health related outcomes in this population. Therefore, the objective of this study was to determine self-paced walking speed and other characteristics of ambulation in a group of people with T2D who had recently completed the FSP.

2.2.0 Research design and methods:

A convenience sample of 19 participants with T2D (11 males, 8 females) were recruited after they had completed the FSP, a 16 week pedometer based lifestyle program for individuals with T2D designed to increase steps/day. Eligible participants were diagnosed with T2D, 40 –70 years of age, not taking insulin, without physical limitations, not currently enrolled in another PA program and accumulating < 8,800 pedometer-determined steps/day. The 3-day average pedometer determined PA following the FSP was 9344 steps/day.

Ambulation data was collected by participants wearing an Activity Monitoring Pod 331 (AMP) (Dynastream, Cochrane, Alberta, Canada) for 3 consecutive days during waking hours. The AMP is worn above the ankle in a neoprene pouch. Sensors within the AMP detect the angular velocity of the leg; an algorithm in the AMP calculates mean velocity and length of that stride. The AMP classifies activity into 3 categories: (1) Inactive: sitting, lying or standing (i.e. when the wearer did not take any steps for at least 20 seconds), (2) Active: movement that includes those associated with daily tasks such as, walking to a filing cabinet, or cleaning house or (3) Locomotion: intentional ambulation where the wearer took at least 20 consecutive steps, for example, walking in the shopping mall. Within the active and locomotion categories, step count, average

speed, average cadence, duration and total distance traveled were calculated. Only data in the locomotion category are presented herein. Data were downloaded from the device to a computer using manufacturer-supplied software. Data were not normally distributed, therefore the median, 25^{th} and 75^{th} percentiles were calculated. Independent treadmill testing has shown the AMP accurately reflects walking speeds between 0 and 6.9 km/hr.

2.3.0 Results:

Participant characteristics were as follows: (mean ± S.D., (95%CI)): age = 54.1 ± 7.7 (50.3 – 57.8), BMI = 33.4 ± 4.9 kg/m^2 (31.0 – 35.7) and HbA_{1c} = 6.7 ± 0.9 (6.3 – 7.2). Characteristics of walking in the locomotion category are shown in Table 1. The median speed of walking in locomotion was 3.3 km/h. Physical activity (walking) ranged from 4,508 to 29,979 steps/day and locomotion walking speed ranged from 2.2 to 4.7km/h; these variables were positively associated ($r = 0.6$, $P = 0.01$). All but one of the subjects walked $\geq$ 4.0 km/hr for at least 1 minute during the monitoring period.

2.4.0 Discussion:

Median walking speed of this cohort was 3.3 km/hr and thus does not meet the walking speed commonly accepted as moderately intense physical activity (Ainsworth et al., 2000). This is one of the first studies to directly measure self-paced walking speed in people with T2D who have recently completed a behaviour modification program intended to increase physical activity. The number of daily steps taken is close to a popular public health goal of 10,000 steps/day and the time spent in locomotion approximates current recommendations for physical activity (Health Canada, 1998; United States Department of Health and Human Services, 1996; Pate et al., 1995). The

low walking speed observed in this study suggests that health benefits may not be fully achieved even though participants approximate popular volume recommendations.

Although participants in this study walked at a slow absolute speed, it is possible their relative exertion reached 40-60% $V0_2max$. Relative intensity of walking was not measured in this study and is an important measurement to consider in future studies. The relative intensity of self-paced walking of individuals with T2D is not known. The modest improvements in physiological outcomes achieved in the FSP suggests that self-paced walking in people with T2D may not approach the absolute intensity recommended for health benefits.

Numerous devices for monitoring ambulatory activity have been developed (Tudor–Locke & Myers, 2000). The pedometer has gained wide acceptance as a cost effective, reliable measure of steps/day (Tudor–Locke & Myers, 2001; Basset et al., 1996), but it has a limited ability to capture more extensive characteristics of walking such as speed. The AMP is a novel device suitable for collecting detailed ambulatory information, although it may be less accessible to a broad population due to its relatively high cost (~$1,600 CDN) and the technical knowledge required to operate the device. Combining a pedometer with a stopwatch may be a feasible way to monitor walking speed.

2.5.0 Conclusion:

The FSP employs the simple message of walk more steps/day. The slow walking speed observed (3.3 km/hr) and the limited time spent at this intensity after completing the FSP suggests this aspect of walking may need specific instruction in order to optimize health benefits derived from self-paced walking. If relative intensity appears to be a

limiting factor, participants may benefit from additional conditioning to manage the demands of increased walking speeds.

Table 2.1 Median, 25th and 75th percentiles of 3-day averaged ambulatory characteristics obtained from an activity monitoring pod[1].

Ambulation Characteristic	Median	25th Percentile	75th Percentile
Total daily steps	9,150	5,394	11,469
Locomotion steps	5,331	2,444	7,015
Locomotion walking speed ($km \cdot h^{-1}$)	3.3	2.9	3.7
Locomotion cadence ($steps \cdot min^{-1}$)	106	102	111
Time spent in locomotion (min)	49.4	26.1	58.5
Distance in locomotion (km)	2.7	1.2	4.2
Time spent at or above 4.0 km/hr (min:sec)	06:13	02:06	27:25

[1] n=19 subjects

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Chapter 3 - Walking faster: Distilling a complex prescription for Type 2 diabetes management through pedometry.[1]

3.1.0 Introduction:

With the growth of pedometry, physical activity recommendations have been distilled to a simple focus on ambulatory volume (i.e.10,000 steps/day). Although energy balance may be most affected by volume, the concomitant lack of focus on physical activity intensity, may undermine realization of intensity-dependent outcomes for those with Type 2 diabetes (T2D), particularly cardiorespiratory fitness because of its' inverse association with hemoglobin A_{1c} (Boulé et al., 2001) and its' predictive power for cardiovascular mortality and morbidity in this population (Church et al., 2005; Katzmarzyk et al., 2004; Blair et al., 2004; Blair et al., 1996).

Historically, a multi-component framework, commonly known as FITT, was used to prescribe how often (Frequency/week), at what Intensity (typically as indicated by heart rate), for how long (duration or Time), and what Type (typically aerobic), of activity one should pursue for health or performance outcomes. At a population level, there has been a secular trend in the emphasis on the interrelated factors of FITT. For example, in 1975, physical activity recommendations promoted aerobic exercise (type), 3-5 days/week (frequency), at 70-90% of heart rate reserve (intensity), and for 20-45 minutes (time). By 2000, recommendations had evolved to promote aerobic activity, 7 days/week, at an intensity of 40-85% of heart rate reserve, and for ≥20 minutes (Blair et al., 2004). The variables that compose this framework for prescription are contained within the clinical practice guidelines from both the American Diabetes Association

[1] A version of Chapter 3 has been published as a brief report: Johnson ST, McCargar LJ, Bell GJ, Tudor-Locke C, Harber VJ, Bell RC. Walking faster: distilling a complex prescription for type 2 diabetes management through pedometry. **Diabetes Care** 29(7):1654 – 1655, 2006

(ADA) and the Canadian Diabetes Association (CDA) (ADA, 2001; CDA, 2003). Regardless of the details of the framework underlying these recommendations, however, the challenge remains how to 1) feasibly translate all FITT factors outside of the exercise physiology laboratory and 2) motivate lifelong physical activity in the T2D population. Pedometers may help meet both these challenges.

We recently reported that individuals with T2D naturally walk at a speed (intensity) that is slower than that associated with the minimal intensity (i.e., moderate) required to derive health benefit, despite increasing their number of steps taken/day (Johnson et al., 2005). Hence, we evaluated a simple educational framework designed to help individuals with T2D "Pick up the Pace" (PUP i.e., increasing the intensity by increasing the speed of walking), 30 min/day on at least 3 days/week within the context of a pedometer-based program. We hypothesized that increased walking speed would result in an improved metabolic risk profile among people with established T2D, specifically targeting glycemia and cardiorespiratory fitness.

3.2.0 Research design and methods:

A convenience sample of 11 individuals with T2D were recruited. A total of 8 (5 males, 3 females) completed the 12 week program. Reasons for withdrawal included: illness (n= 2) and work commitments (n= 1). All participants had recently (within 6 months) completed a 16 week pedometer based lifestyle program for individuals with T2D, called the First Step Program (FSP) designed to increase steps/day (Tudor-Locke et al., 2004; Tudor-Locke et al., 2002). Eligible, participants were diagnosed with T2D, 40 –70 years of age, not taking insulin, without physical limitations, not currently enrolled in another physical activity program and accumulating ~ 8,000 pedometer-determined

steps/day. The self – reported 3-day average pedometer determined steps/day following the FSP was 10,936 ± 4,836.

Participants determined their normal pace by counting steps taken during a 10 min walk with a pedometer and used this to establish a training cadence that was 10% above their usual stepping rate, 30 min/day, for 3 days/week (Appendix A). For example, if a participants' preferred pace was 90 steps/min, they increased their pace to 100 steps/min. Participants practiced their PUP pace in 4 weekly meetings initially, but were unsupervised on their other prescribed PUP walks. During weeks 5-8, participants attended 2 supervised PUP walking sessions, while in weeks 9-12 they were required to attend only 1 supervised session. Participants wore heart rate (HR) monitors (Polar Electro, Oy, Finland) and carried stop watches to monitor time during PUP walking. They also wore accelerometers (AMP 331, Dynastream, Calgary, Alberta, Canada) to detect and record free-living ambulatory characteristics for 7 consecutive days during waking hours, on weeks 1, 4 and 12 of the study. Cardiorespiratory fitness was measured using a modified Bruce graded treadmill protocol before and after the 12 week PUP program (Bruce et al., 1973).

3.3.0 Results[2]

Participant characteristics were as follows: 5M, 3F; mean ± SD, age = 54.4 ± 7.5, BMI = 31.5 ± 4.0 kg/m^2, resting heart rate = 71.5 ± 8.7 beats per minute (bpm), A_{1c} = 6.9 ± 1.2. Average speeds (mean ± SD km/hr) for PUP walking, for non-PUP walking on PUP days and for walking on non-PUP days were: Week 1: 5.2 ± 0.7; 3.2 ± 0.5; and 3.1 ± 0.4 (respectively). At week 4 the speeds were: 5.4 ± 0.7; 3.2 ± 0.5; and 3.1 ± 0.3. At

[2] Appendix B provides additional data collected during this pilot study.

week 12 speeds were: 5.7 ± 0.8, 3.0 ± 0.5, and 3.3 ± 0.4. Average HRs during PUP walking were 125 ± 8, 130 ± 12 and 127 ± 8 bpm, which equated to 74.0 ± 2.0, 77.2 ± 2.0 and 76.7 ± 2.8 % of age-predicted HR maximum during weeks 1, 4 and 12 of the study respectively. Participants consistently rated their perceived exertion during PUP walking as 'hard' (Borg, 1974). HR response to exercise improved significantly over the course of the PUP program, as shown in figure 3.1. Hemoglobin A_{1c} did decrease after the intervention (- 0.35 ± 0.55 %), however this did not reach statistical significance. Further unpublished data originating from this study are presented in Appendix B.

3.4.0 Discussion:

The main finding of this study is that a pedometer and a stopwatch can serve to facilitate increased walking intensity for people with T2D when introduced within an educational framework designed for increasing physical activity. To our knowledge, this is the only study designed to address walking speed through the use of a pedometer and a stopwatch in a T2D population.

The PUP program prescribed increased walking speeds, and therefore intensity of walking during 30 minute bouts, to a level that elicited significant improvements in cardiorespiratory fitness over 12 weeks, in a group already walking 10,000 + steps/day. Overall, participants incorporated all FITT factors, most notably intensity, into their ambulatory activity, thereby meeting clinical practice guidelines suggested by the ADA and CDA (ADA, 2001; CDA, 2003). The program employed simple tools (pedometer and stop-watch), and a simple message to Pick up the Pace. It provided opportunity for skill-building and continued support through limited semi-structured meetings with minimal resource input.

3.5.0 Conclusion:

Our findings highlight the importance of each component of the FITT framework and provide proof-of-principle that a simple educational strategy can be used to help to translate the complex, foundational principles of exercise physiology prescription into a walking routine that can be promoted by healthcare providers and implemented by people with T2D with relative ease.

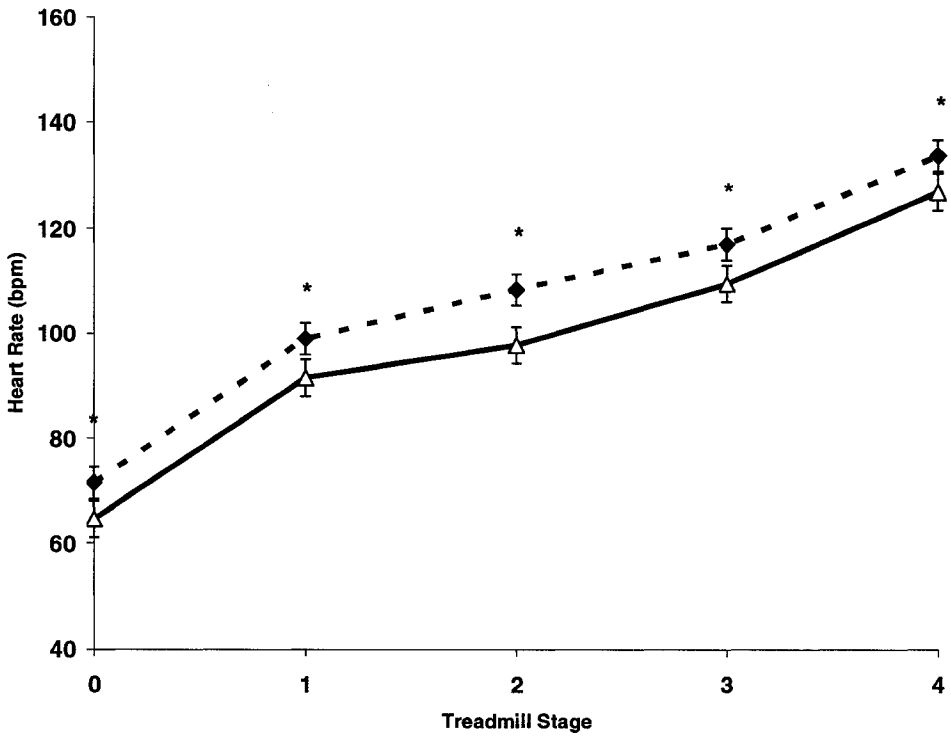

Figure 3.1. Heart rate response to a graded treadmill protocol following participation in a pedometer-based, walking program; black diamonds = baseline; white triangles = after 12 weeks; * significant difference ($p<0.05$).

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Chapter 4 – Improved cardiovascular outcomes after a progressive lifestyle intervention for Type 2 diabetes

4.1.0 Introduction:

Both the American and Canadian Diabetes Association Clinical Practice Guidelines (CPGs) recommend a sound lifestyle approach to disease management which includes attention to both diet and physical activity (ADA, 2006; CDA, 2003). Briefly, the guidelines suggest that the accumulation of at least 30mins of moderate intensity physical activity on most days of the week and the consumption of a diet that is low in saturated fat and higher in monounsaturated fat, emphasizing both quantity and quality of carbohydrate, particularly the Glycemic Index (GI), will help to achieve a variety of clinically relevant goals that include improved glycemic control, lipid profile as well as a healthy body weight. Although these recommendations are acknowledged as important (i.e., for delaying the arrival of, or progression to micro – and macrovascular complications of diabetes) a structured management framework that incorporates the CPGs that is relatively easy to implement (i.e. cost-effective), sustainable and acceptable to health professionals and patients alike remains elusive.

From a clinical perspective, healthy nutrition and physical activity are often approached in concert and various counseling strategies are employed to help patients with Type 2 diabetes (T2D) improve both of these behaviours. The objectives of both of these arms of lifestyle modification are to address issues of energy balance in relation to weight management, glycemic control and cardiovascular disease risk and evidence in support of these objectives for those with T2D is beginning to emerge (Espeland, 2007).

We recently reported that individuals with T2D who achieved nearly 10,000 steps/day, a volume that is commonly regarded and recommended as an effective physical activity goal for T2D, self-selected a walking speed that was slower (less intense) than that recommended to derive health benefit (Johnson et al., 2005). Additionally, we and others have shown that subjects with T2D enrolled in self-paced, pedometer-based lifestyle programs show little, if any, significant improvement in the traditional physiological outcomes including blood pressure, waist circumference, body weight, resting heart rate and glycemic control, despite increasing their physical activity volume measured as steps/day (Tudor-Locke et al., 2004; Araiza et al., 2006). This suggests that simply focusing on increasing total daily steps may not be a sufficient physical activity recommendation for improved clinical outcomes in this population. We tested this hypothesis and found that when people with T2D are provided with targeted instruction on how to increase their walking speed for 30 minutes/day on 3 days/week this can lead to positive physiological outcomes (Johnson et al., 2006). In this pilot project, subjects used a combination of pedometer and stop watch as feedback and monitoring tools, and met current Clinical Practice Guidelines for physical activity within a program that included minimal resource input and patient contact.

Evidence from observational and controlled trials suggest that consideration of both the quality and quantity of dietary carbohydrate helps to achieve positive short and long-term glycemic control (Mayer-Davis 2006; Brand-Miller et al., 2003; Wolver et al., 1996) and improve traditional risk factors for CVD (McMillan-Price et al., 2006; Ebbeling et al, 2005). However, thorough evaluations of theory-based programs that are designed to help individuals with T2D make positive changes to improve the GI of their

diet are lacking. Numerous organizations and reference materials (i.e., www.glycemicindex.com; www.diabetes.ca/section_about/glycemic.asp) have been developed to facilitate changing dietary carbohydrate consumption patterns to increase the intake of foods with a low-GI. Thus, in order for diet and physical activity to continue to be considered the cornerstones of diabetes self-management, straightforward, effective and low-cost lifestyle programs that combine both diet and physical activity need to be developed and evaluated.

Unlike pharmacologic agents which are designed to target a specific biomarker (e.g. statins target hypercholesterolemia and metformin targets glycemic control), diet and physical activity both have plieotropic effects that positively influence a number of chronic disease-related biomarkers including insulin sensitivity and possibly insulin secretion (Thomas et al., 2007; Snowling & Hopkins, 2006; Ludwig, 2005). Participating in moderate intensity physical activity and consuming a low GI diet have the potential to work synergistically to improve important clinical outcomes for people with T2D our objective was to compare changes in measures of glycemic control and cardiorespiratory fitness of people with T2D. changes in measures of glycemic control and cardiorespiratory fitness of people with T2D who received either a basic lifestyle modification program focusing on the quantity of daily physical activity and dietary carbohydrate versus an enhanced lifestyle program that emphasized both the daily quantity and quality of physical activity and dietary carbohydrate.

We hypothesized that upon completion of the Enhanced program, subjects would display greater cardiorespiratory fitness and better glycemic control compared to subjects in the basic program.

4.2.0 Research design and methods:

Participants (n=44) with T2D were recruited through a local advertising campaign (television and newspaper; see Figure 1). Eligibility criteria included: 40 – 70 years of age, not taking insulin, without physical limitations, not currently enrolled in another physical activity program, no gastrointestinal disorders, and previous attendance completion of at least one diabetes education course. Evidence of self-reported cardiovascular history at prescreening was considered a contraindication to study participation; for those without a cardiovascular history those with higher cardiovascular risk (based on age, resting blood pressure and heart rate, waist circumference, BMI, family history of CVD and current medication use) were triaged and evaluated by a Cardiologist (RW) before entering phase 2. No participants were disallowed from participating in phase 2. The study protocol was approved by the Health Research Ethics Board at the University of Alberta.

Following telephone prescreening, potential participants attended an information meeting at which the study was explained in detail and interested participants gave their informed consent. As part of this meeting, participants were asked to walk at their self-selected normal pace for 15min on a 200m indoor track while wearing a dual-biaxial accelerometer and pedometer (AMP 331, Dynastream, Calgary, Alberta, Canada) to accurately assess their walking speed in velocity and cadence (steps/min). Those whose average pace exceeded 5.0 km/hr were excluded from the study to avoid the potential that they would have to run, rather than walk faster, in the second phase of the study (explained in detail below).

The intervention consisted of 2 phases that lasted for a total of 24 weeks. (Figure 4.1). The first 12 weeks (phase I) was a run-in period and was adapted from the First Step Program as has been described previously (Tudor-Locke et al., 2004; Tudor-Locke et al., 2002). The goal for all participants in the first phase was to increase their number of steps/day. Each participant set their own individual daily step goals, initially based on their average steps/day (3 consecutive days including one weekend day) measured at the time of recruitment. At the onset of phase 1, participants attended a weekly group meeting that included a supervised walking session for the first 4 weeks. During weeks 5-12, walking sessions were held once weekly and attendance was optional. A resource manual and log book (Appendix C) were provided at the first meeting to facilitate goal setting and to record the total number of steps/day.

At the end of phase 1 (week 12), participants were randomly assigned to either the basic or enhanced lifestyle program (Basic or Enhanced). Both programs are based on Social Cognitive Theory and include principles of goal setting, self-monitoring, and feedback in combination with ongoing evaluation of self-efficacy (Bandura et al., 1977). Both programs were designed to use readily available tools, to be easy to implement and practically based to facilitate their translation to a broader clinical and community setting. In the second phase, the Basic program followed the same goals for walking as in phase 1, (i.e. increase total daily steps). The dietary education portion of the Basic program incorporated the concepts of the Glycemic Index (GI) and was taught during the first two weeks using a 15min slide presentation and print material from the Canadian Diabetes Association (CDA, 2005) along with a resource manual (Appendix D & E). The dietary goals were to increase the number of low-GI food choices on a daily basis.

The Enhanced program had a volume and a speed goal for walking; for the volume goal, participants were to continue to achieve their individual daily number of steps which they set at the end of phase 1; for the speed goal, they were taught how to increase their walking speed by 10% during a 30min walk, and were asked to incorporate this faster walking pace for 30mins/day on 3 days/week. For example, if participants' preferred pace was 90 steps/min, they increased their pace to approximately 100 steps/min. Participants were asked to perform their faster walking in bouts lasting no less than 10mins. Subjects in the Enhanced program were given a second pedometer and a stopwatch to help them measure and monitor their faster steps, along with a resource manual and a set of small cards on which to record the faster steps immediately after they were performed (Appendix F).

Dietary education for the Enhanced program incorporated the same general concepts provided to the Basic program, but was enhanced through a goal setting framework that included: improving daily GI by targeting food exchanges (i.e. replace white and whole wheat bread with pumpernickel) on at least 3 days/week and to make at least 2 exchanges over the course of those days (previous pilot data indicated increasing the number of low-GI food servings by this amount was feasible (unpublished data).

Participants in the Enhanced program were provided with a resource manual that contained examples of low, medium and high-GI foods (Appendix F). Participants were encouraged to seek examples of low-GI food choices from reputable resources (i.e. www. glycemicindex.com). Meal targeting was also used as a strategy to improve dietary carbohydrate quality (i.e., focusing on changing the carbohydrate source for breakfasts).

Participants were asked to record the number of high to low-GI exchanges they made and what foods were exchanged.

During phase 2, all participants were asked to attend one weekly meeting that included a supervised walking session (weeks 13-16) within their assigned program. From weeks 17-20, they attended 2 weekly booster sessions and during weeks 21-24 they attended 1 booster session. No formal instructions for diet or walking were provided at these booster sessions.

Cardiorespiratory fitness, measured as resting heart rate (RHR), and glycemic control, measured by glycosylated hemoglobin (A_{1c}), were the main outcomes of interest. These 2 variables were selected because of the known inverse association between fitness and glycemic control (Boulé et al., 2001) and because they have clear links to reduced risk for long term cardiovascular complications (UKPDS 34, 1998).

Anthropometric, behavioural and metabolic measures were assessed at baseline (time of recruitment to the study), 12 weeks (end of phase 1), and 24 weeks (end of phase 2). Resting heart rate and blood pressure were measured using a digital sphygmomanometer (Quick Response, LifeSource™, model UA-787,San Jose, California, USA) and reported as the average of 3 consecutive measurements separated by 3-5 mins. Body weight (Stand-on-Scale, Seca 220) and height (QuickMedical, Heighttronic™, Snoqualmie, Washington, USA) along with waist and hip girth (non-stretch Teflon™ tape) were measured with participants wearing a standard hospital gown with no shoes or stockings. All measurements were taken in triplicate and averaged. Each participant was instructed on how to accurately record dietary intake using 3-day food records and how to use their pedometer (Yamax SW 200, Koyto, Japan) and record their steps/day as previously

described (Tudor-Locke et al., 2002, Tudor-Locke & Myers, 2002). Dietary data were analyzed using Food Processor Nutrient Analysis Software v. 9.9.0 (ESHA Research Salem, Oregon, USA). At 12 and 24 weeks, A_{1c} (DCA 2000®+, Bayer Inc., Toronto, ON, Canada) was added to the measurements completed at baseline.

Average daily glycemic index (GI) and 3-day averaged total daily glycemic load (GL) were calculated from published tables (Foster-Powell et al., 2002) with additional information retrieved from an online database (www.glycemicindex.com) using glucose as the reference food. When possible, the glycemic indices of foods were estimated with the mean value of several studies in the updated GI and GL table by Foster-Powell et al (Foster-Powell et al., 2002). Methods of food preparation were taken into account, when available. For unclassified GI foods, substitutions were made with defined food items, based on a similar carbohydrate, fiber, and acidity content (e.g.. blueberries are not rated, therefore grapes were selected). Items not included in the GI and GL calculations were those without a GI rating and for which a food of similar carbohydrate composition could not be found. Individual daily average GI was calculated by totaling the GI ratings of all carbohydrate-containing foods identified from each individual day of the 3-day food records, for each study participant. This value was then divided by the total number of GI-rated foods consumed (Average GI = [Sum(GI value of each food)/Number of GI-rated foods]). Glycemic load (GL) was calculated by subtracting the total gram weight of fiber from the total gram weight of carbohydrate in each portion of carbohydrate-containing food; in doing so, the total available carbohydrate was determined. Total available carbohydrate was then multiplied by its respective GI. From this, total daily GL was determined by summing the calculated GL for each individual GI rated food and

dividing the total GL by 100. Three day averages, for each day of each participant's 3-day food record were combined to determine average total daily GL.

Analyses for phase 1 of this study were completed using analysis of variance with repeated measures (RM-ANOVA). The independent variable for each statistical test was the intervention group, and the dependent variable(s) were the clinical and behavioural outcomes presented in Tables 4.1

For phase 2, a one-way analysis of covariance (ANCOVA) was conducted to compare the effect of the Basic versus Enhanced lifestyle program on behavioural and clinical outcomes. The independent variable for the ANCOVA was the intervention group (Basic or Enhanced), and the dependent variables were the clinical and behavioural outcomes as presented in Tables 4.2 and 4.3. For each ANCOVA, participants' week 12 score for each dependent variable was used as the covariate (Vickers & Altman, 2001).

Bivariate associations were calculated and are reported as Pearson product coefficients. All descriptive data are presented as mean ± standard deviation unless otherwise stated. A p value of ≤ 0.05 was considered significant. Data were analyzed with SPSS v.15.0 (SPSS Inc., Chicago, Illinois)

4.3.0 Results:[1]

Overall, at baseline participants (n= 41) were in their mid-50s (mean ± SD= 56.5 ± 7.2 years) and generally considered overweight to obese (range of BMI= 23.6–49.5 kg/m^2). Fifty- eight percent were female and the average time since diagnosis with T2D was 56.5 ± 55.7 months for the entire group. Nearly three-quarters (73%) of the

[1] Appendix G provides additional data collected during this study.

participants reported taking oral antidiabetic agents and nearly half reported taking a statin and an ACE-inhibitor (44 and 42%, respectively). At baseline, characteristics of their self-selected walking over 15mins were: speed = 4.20 ± 0.6 km/hr and cadence = 115 ± 9 steps/min. Further baseline clinical characteristics are shown in Table 4.1.

A total of 41 individuals completed phase 1 of this study (Figure 4.1). One participant refused all clinical measures except A_{1c}; thus, all data reported from phase 1 reflect the mean ± standard deviation of 40 participants unless otherwise stated. Three participants (7%) did not complete phase 1 and therefore did not complete the 12 week assessment due to family illness (n=2) and loss to follow up (n=1). Attendance at weekly group meetings in weeks 1 through 4 was: 95, 93, 91 and 91% respectively.

During phase 1, (Table 4.1) participants increased their steps from baseline by approximately 1,700 steps/day ($p<0.05$). Significant reductions in body weight, BMI, systolic and diastolic blood pressure were observed ($p<0.05$). No changes were observed in waist or hip circumference or resting heart rate. There were no significant reductions found for total energy or carbohydrate intake, daily average GI, daily total GL, or fiber intake during phase 1.

At the end of phase 2, (Table 4.2) the participants in the Enhanced program showed a significant reduction in resting heart rate ($p<0.05$) compared with those in the Basic program. A significant inverse association was found between resting heart rate and A_{1c} ($r = - 0.5$, $p= 0.02$) for the Enhanced group but not for the Basic group ($r = 0.2$, $p= 0.4$). There were no group differences for total daily steps or for any of the other variables assessed (Table 4.2 and 4.3). The average attendance for the Basic group the 4 weekly program sessions in phase 2 was: 100, 82, 63 and 75% respectively. While the

average attendance for the Enhanced group was: 100, 77, 77 and 86% for each weekly program session.

Of those in the Enhanced program who returned their step logs (n= 16), 36% of their daily steps were taken while walking faster at an average pedometer recorded cadence of 3,936 ± 422 steps/30min. For those in the Enhanced program, a total of 36 days of walking faster indicated 100% compliance. Adherence to the prescription to walk faster was high; median of 30 min bouts = 78%, range 0 – 183%. We have reported the median in this case because two participants exceeded the recommendations whereby one recorded 63 days and another recorded 39 days of 30min bouts and on those 39 days the latter participant recorded an extra 30 min bout on 27 days.

Each dependent dietary outcome variable was adjusted using the dietary intake data from the beginning of phase 2 (as a covariate). These data showed total dietary carbohydrate intake did not differ between groups over phase 2. Daily average GI and total daily GL were not statistically different between the groups. The Basic group tended to increase their total dietary fibre intake.

4.4.0 Discussion:

Among a group of people with T2D, participation in a lifestyle intervention with a progressive PA component that incorporated a goal of walking faster on 3 days/week, 30mins/day in addition to walking more than at baseline led to improvements in cardiorespiratory fitness as measured by RHR. This improvement in RHR was greater than that observed in a group walking the same number of steps without instruction to walk faster.

The benefits of PA in this population are well known but it is less obvious how best to help people achieve these benefits. Our results are consistent with the conclusions of recent meta-analyses (Thomas et al., 2007; Snowling & Hopkins, 2006), in that PA can improve the metabolic health for individuals with T2D. The Enhanced program used in this study provides an acceptable vehicle to promote these changes in the context of a straightforward and practical pedometer-based walking program. The improvements observed in cardiovascular outcomes over the 24 weeks of this study are clinically relevant since cardiorespiratory fitness is a robust predictor of cardiovascular mortality and morbidity in both the healthy and T2D population (Church et al., 2005; Church et al., 2004; Myers et al., 2002; Lee et al., 1999; Wei et al., 1999; Blair et al., 1996; Kohl et al., 1992).

Pedometer based studies have yielded positive health outcomes in people without T2D, however. Chan et al., (2004) observed a reduction in resting heart rate among 106 sedentary but otherwise healthy workers who increased their total daily steps by ~ 3,300 after 12 weeks. Similarly, an improved cardiovascular risk profile, in particular systolic and diastolic blood pressure, was detected in healthy people following a 12 week pedometer based intervention that encouraged brisk walking (Tully et al., 2005). To our knowledge, and relevant to the current study, the work by Tully and colleagues (2005) is the only other study promoting more intense walking with the use of a pedometer. The results of that study may not be generalizable to those with T2D as the subjects in their study were described as generally healthy. Here, we present new information for cardiovascular benefit in the T2D population that occurred after people improved a portion of their total daily steps on 3 days/week. Moreover, our results suggest that

improving the quality of a small portion of total daily steps (~30%) through the use of a pedometer is a novel approach for one of the cornerstones of diabetes management. Further, the fact that they made use of a pedometer and a stop watch shows that straightforward inexpensive tools can be utilized to help people achieve this lifestyle management goal that agrees with current clinical practice guidelines. This has important implications for acceptability and feasibility when attempting to improve the quality of PA for chronic disease management.

The reduction in resting heart rate among participants in our Enhanced program has considerable clinical significance. Based on meta-analytic data compiled from healthy older adults participating in exercise programs of higher intensity, Huang and colleagues (2005) suggest a reduction in resting heart rate of approximately 6 bpm would confer an increase in stroke volume of nearly 7mL/beat, (this assumes cardiac output is = 5L/min, resting heart rate = 70 bpm). Thus, the observed cardiac adaptation of 4 bpm in the Enhanced program would suggest enhanced cardiac mechanical efficiency and potentially lowered myocardial oxygen demand through improved cardiovascular efficiency. Given the fact that cardiorespiratory fitness is a robust predictor of clinical outcomes such as all-cause and CVD related mortality, improved cardiorespiratory fitness should be considered an important independent clinical outcome in this population (Duncan, 2006; Kraus, 2005).

Pedometers and interventions or programs incorporating this basic tool have demonstrated to be effective for increasing PA and clinical outcomes in healthy adults and in those with chronic diseases (Albright & Thompson, 2006; Tudor-Locke & Bassett, 2005; Moreau et al., 2001; Iwane et al., 2000; Yamanouchi et al., 1995). In general, poor

compliance to behavioural interventions is common. However, the approach used in this study seems to have overcome some of the known barriers that limit adherence to behavioural goals for PA (Sherman et al., 2000; Chao et al., 2000). Thus, given the significant increase in total daily steps after the run-in period, the low rate of attrition, the high attendance at scheduled sessions and the adherence to the walking prescription by the participants of the Basic and Enhanced programs over the 24 weeks of this study, it can be concluded that a progressive approach to an Enhanced pedometer-based lifestyle prescription as presented in this study is an acceptable and effective approach to PA for disease management over at least a 6 month period.

Despite the reduction in resting heart rate, we observed no significant change in A_{1c} between the treatment groups. To understand this outcome a number of variables must be considered: first, the average A_{1c} observed prior to the intervention suggests this group was well controlled. This may have reduced the potential for A_{1c} to be further reduced through any changes including diet and PA. However, we did find a significant inverse association between changes in RHR and A_{1c} in the Enhanced group though not in the Basic group. This result is agreement with the suggestion by Boulé et al., (2001) that PA (exercise) of greater aerobic intensity is associated with improved cardiorespiratory fitness and A_{1c}.

Over the first 12 weeks (phase 1) of this program when people were increasing only their steps/day, systolic and diastolic blood pressures were reduced. These improvements exceeded our expectations because previous pedometer based studies in this population have shown very modest improvements in traditional CVD outcomes. For example, Tudor-Locke et al., (2004) found that despite a nearly two-fold increase in total

daily steps (~ 6,000 to 9,000), no reductions in resting heart rate, systolic or diastolic blood pressure were observed after 16 weeks. Similarly, participants in a pedometer based study by Araiza (2006) failed to achieve reductions in their systolic or diastolic blood pressure. It should be noted the study from Araiza (2006) lasted only 6 weeks and may not have been long enough to show improvements in traditional markers of CVD even though there was an increase in total daily steps. Subjects in our study were accumulating approximately the same number of steps/day as those in these other studies, therefore the effects on blood pressure may reflect other differences between the subjects pools.Current literature in the area of GI suggests that an approach that promotes exchanging foods of lower-GI for those with a higher-GI will result in improved glycemic control (Brand-Miller & Foster-Powell, 1999). In order to facilitate this knowledge translation, individualized counseling is often recommended (CDA, 2003; Sherman et al., 2000). In this study we based our dietary intervention to complement the PA intervention in a group setting and it is likely that the Enhanced framework may not have been a more effective approach for improving overall dietary GI. Although no statistical difference was found, a trend for increased consumption of total dietary fibre by the Basic group was evident and suggests that, rather simply, a daily goal for increasing the total number of low-GI servings leads to an improvement in the quality of dietary carbohydrate separate from strictly considering GI.

Despite the new evidence presented, the results of this study must be interpreted with a number of caveats. Firstly, it is possible that the lifestyle modification programs implemented had a positive impact on A_{1c} that we did not detect: this was not the outcome that we powered the study to detect. We based our power calculation for this

study on RHR because participants in our pilot study (Johnson et al., 2006) showed improved cardiorespiratory fitness. Free-living individuals with T2D typically accumulate ~ 6,500 steps/day (Tudor-Locke et al., 2002) suggesting that at baseline, our group of participants could be considered moderately to highly active and this may, in part, help to explain their good glycemic control (A_{1c} = 6.5; a normal A_{1c} is$\leq$ 6.1 according to the 2003 CDA Clinical Practice Guidelines), therefore generalizing these results to other less well controlled and less physically active patients with T2D must be approached with caution. Secondly, it is plausible that the oral antihyperglycemic agents and cardiovascular related medications taken by subjects in this study may have had some impact on the outcomes measured. Subjects in this study did not report having made any significant changes in medication use during the course of the trial, despite being asked specifically to report any such changes. Therefore, we believe that pharmacologic therapy among those who participated in this study had little impact on the study outcomes.

Thirdly, a 2x2 factorial design may have been better suited to determine treatment outcomes for the separate independent variables of diet or exercise. A strength of our approach was that the lifestyle programs we compared are in keeping with current clinical practice guidelines. Since the current Clinical Practice Guidelines do not provide a specific framework for meeting lifestyle recommendations and since the lifestyle goals for the Basic group are consistent with the current Clinical Practice Guidelines for what might be considered 'usual' or 'standard care' we did not include a 'usual care' control group *per se.* The intent of this study was to help define a framework for informing a best practice; thus, subjects in the Basic program served as a relative control group.

Moreover, self-paced pedometer based lifestyle programs have shown that despite increasing daily physical activity through increasing total daily steps, the associated effects on clinical outcomes have been be relatively small (Araiza et al., 2006; Tudor-Locke et al, 2004).

Therefore the combination of diet and PA management recommendations provided a realistic yet comprehensive approach to lifestyle modification. The Basic program reflects what might be currently recommended by diabetes educators and health care specialists but is likely provides more instruction and structure than what is currently considered usual care. Because of this, the observed difference between the two programs may underestimate the effects of our Enhanced program.

4.5.0 Conclusion:

This novel approach to lifestyle management for T2D has provided new and important evidence that people with T2D can achieve improvements in cardiovascular fitness through a straightforward program that first targets increasing the total number of steps/day and then adding a goal of increasing the walking speed for 30mins/day on 3 days/week. A comparable component for dietary counseling, particularly focusing on dietary GI, remains to be confirmed. Thus, lifestyle programs developed and administered by healthcare providers should begin with a basic quantity for the volume of PA and progress to an enhanced approach that focuses on specific quality aspects like the speed and frequency of walking that agree with current clinical practice guidelines while incorporating current evidence-based recommendations for medical nutrition therapy.

Figure 4.1: Flow diagram for a 24 week lifestyle intervention

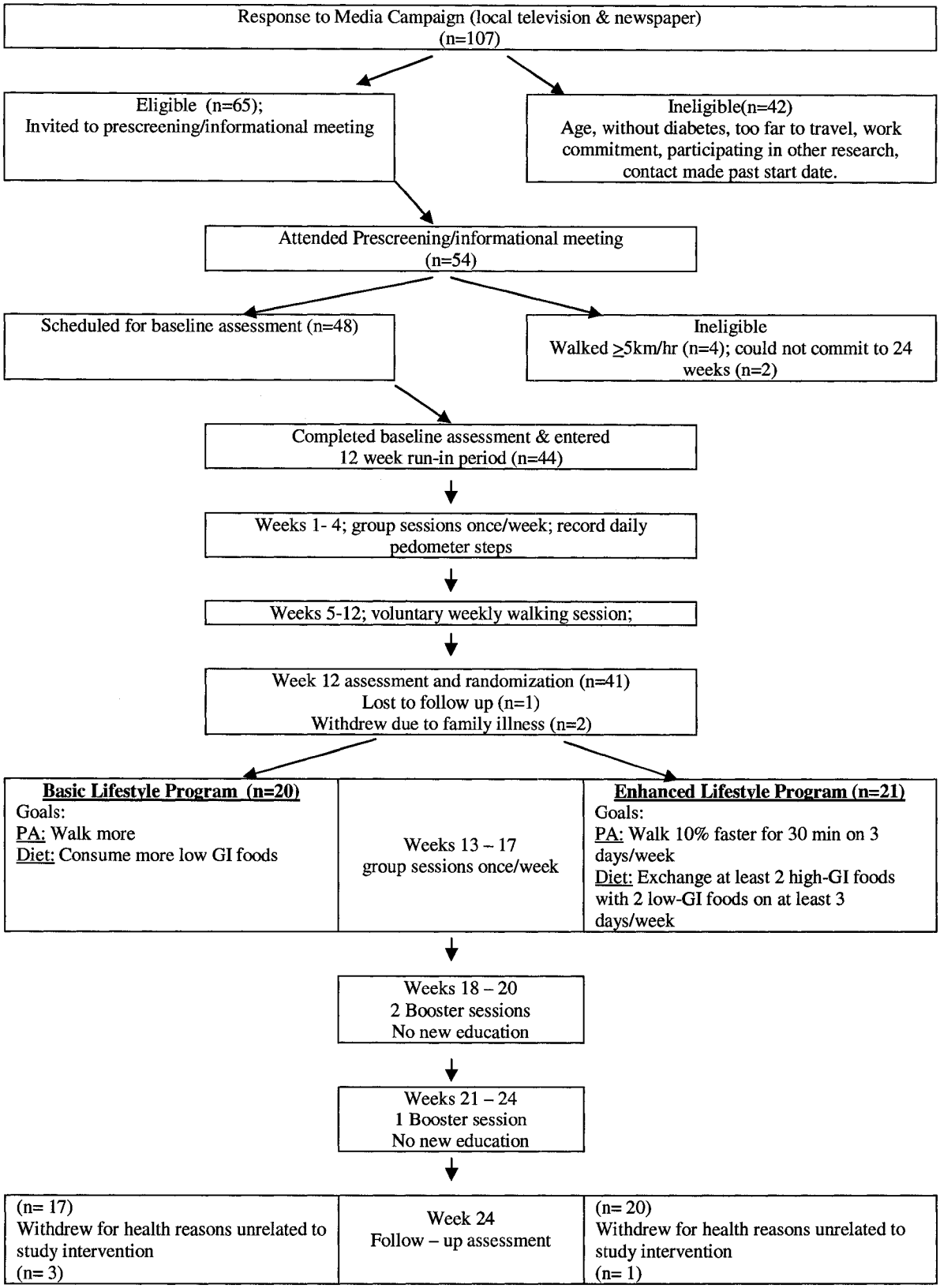

Table 4.1 Mean change scores (95% CI) following a 12 week run-in period.

Variable	Baseline (week 0)	Δ (95% CI)	P Δ
Steps/day[‡]	8948 ± 3288	1685 (330 to 3040)*	0.02
Anthropometry			
Weight (kg)	91.2 ± 21.4	- 0.9 (-0.4 to - 1.5) [‖]	0.002
BMI (kg/m^2)	32.7 ± 6.1	- 0.4 (-0.2 to - 0.6) [‖]	0.001
Waist circumference (cm)	108.9 ± 17.7	- 1.1 (0.3 to - 2.4)	0.11
Hip circumference (cm)	113.5 ± 13.1	- 0.5 (0.4 to - 1.4)	0.23
Resting Blood Pressure			
Systolic (mmHg)	127.5 ± 13.9	- 6.0 (-2.4 to - 9.7) [‖]	0.002
Diastolic (mmHg)	84.1 ± 8.3	- 5.2 (- 3.1 to -7.3) [§]	<0.001
Resting heart rate (bpm)	75 ± 11	-0.0 (-3.0 to 3.1)	0.99
Diet [†]			
Energy (kcal)	2304 ± 696	- 148 (-342 to 46)	0.13
Glycemic Index	51.7 ± 5.6	- 0.8 (-2.3 to 0.8)	0.32
Glycemic Load	121.7 ± 5.5	- 3.1 (-16.1 to 10.0)	0.64
Total carbohydrate (g)	273.7 ± 96.3	- 9 7 (-33.2 to 13.9)	0.41
Total fibre (g)	25.2 ± 9.2	- 0.4 (-3.4 to 2.7)	0.80

Values represent means ± standard deviation; Δ = (week 12 – week 0); *n=1 refused all clinical measures;[‡] n=38 returned step logs; [†] dietary data n = 36; *P<0.05;[‖]P<0.01; [§]P<0.001

Table 4.2. Adjusted change scores (95% CI) for cardiovascular indicators from randomization at week 12 to follow-up at week 24

Variable	Week 12	Δ_{ADJ} (95%CI) *	P Δ_{ADJ}
Resting heart rate (bpm)			
Enhanced	74.6 ± 12.9	- 4.3 (-8.2 to 0.4) ‖	0.03
Basic	76.1 ± 11.1	2.1 (-1.9 to 6.2)	
Systolic blood pressure (mmHg)			
Enhanced	123.7 ± 13.9	2.1 (- 2.6 to 6.7)	0.53
Basic	119.1 ± 12.4	4.2 (- 0.6 to 9.0)	
Diastolic blood pressure (mmHg)			
Enhanced	78.5 ± 10.1	2.4 (0.5 to 5.2)	0.66
Basic	79.4 ± 10.8	3.3 (0.3 to 6.3)	

Values represent means ± standard deviation. All analysis were completed by intention-to-treat with the last value carried forward. *Δ_{ADJ} = (week 24 – week 12) adjusting for week 12; ‖P<0.05

Table 4.3. Adjusted mean change scores (95% CI) from randomization at week 12 to follow-up at week 24*

Variable	Week 12	Δ_{ADJ}[§] (95%CI)	P Δ_{ADJ}
Weight (kg)			
Enhanced	91.8 ± 20.5	- 1.2 (- 2.0 to - 0.5)	0.92
Basic	88.6 ± 22.3	- 1.2 (- 2.0 to - 0.4)	
BMI (kg/m^2)			
Enhanced	32.7 ± 5.9	- 0.4 (- 0.7 to - 0.2)	0.98
Basic	32.0 ± 6.2	- 0.4 (- 0.7 to - 0.2)	
Waist circumference (cm)			
Enhanced	107.6 ± 16.2	- 0.7 (- 2.5 to 1.0)	0.31
Basic	107.2 ± 19.0	0.6 (- 1.3 to 2.4)	
Hip circumference (cm)			
Enhanced	113.5 ± 12.9	- 1.2 (-2.5 to 0.3)	0.77
Basic	112.5 ± 12.6	- 1.0 (-2.5 to 1.0)	
A1c (%)			
Enhanced	6.5 ± 1.3	0.0 (-0.1 to 0.1)	0.23
Basic	6.4 ± 1.3	0.1 (0.0 to 0.3)	
Steps/day[‡]			
Enhanced (n=21)	10107 ± 4123	- 858 (-1906 to 191)	0.11
Basic (n=17)	11281 ± 4575	- 2142 (-3309 to 975)	
Energy (kcal)[†]			
Enhanced	2237± 647	- 234 (-438 to -32)	0.70
Basic	2054 ± 570	- 177 (-405 to 50)	
Glycemic Index			
Enhanced	51.9 ± 4.1	-1.3 (-3.2 to 0.5)	0.21
Basic	49.6 ± 5.6	-3.1 (-5.2 to -1.0)	
Glycemic Load			
Enhanced	117.2 ± 5.1	- 19.4 (-31.7 to -7.0)	0.72
Basic	120.5 ± 5.1	- 16.1 (-30.0 to -2.2)	
Total carbohydrate (g)			0.26
Enhanced	264.2 ± 82.0	- 34.0 (-58.9 to -9.1)	
Basic	263.7 ± 91.2	- 12.7 (-40.5 to 15.2)	
Total fibre (g)			0.09
Enhanced	26.4 ± 7.3	- 0.6 (-4.7 to 3.6)	
Basic	22.9 ± 11.1	4.7 (0.1 to 9.3)	

Values represent means ± standard deviation; Δ = (week 24 – week 12); All analysis were completed by intention-to-treat with the last value carried forward. *n=1 refused all clinical measures except A_{1c};[‡] n = 38 returned step logs, n = 21 for ELP, n = 17 for BLP; [†] for all dietary data, n= 20 for ELP and n=16 for BLP

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Chapter 5 – Targeting glycemic index: Measurable changes in carbohydrate food choices following a healthy eating and active living program for Type 2 diabetes.

5.1.0 Introduction:

The goals of Medical Nutrition Therapy (MNT) for individuals with Type 2 diabetes (T2D) are to improve and/or maintain overall nutritional status, health and quality of life while preventing acute and long term complications of the disease such as cardiovascular disease (CVD) (American Diabetes Association, 2002; Canadian Diabetes Association 2003). The Canadian Diabetes Association (CDA) advocates and promotes the use of Canada's Food Guide to Healthy Eating (Health Canada, 1993) as an important resource to guide healthy food choices for all people with diabetes (CDA, 2003). The basic principles of Canada's Food Guide to Healthy Eating (CFGHE) include: enjoy a variety of foods, emphasize cereals, breads and other whole grain products vegetables and fruits, choose lower-fat dairy products, leaner meats and foods prepared with little or no fat, achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating while limiting the intake of salt, alcohol and caffeine.

Besides the general nutrition principles listed above, the CDA also provide more detailed nutritional recommendations for individuals with T2D (CDA, 2003) which include: calorie intake from fat should be no greater than 30% of total daily energy requirements and no more than 10% of these should come from each saturated and polyunsaturated fats; fish rich in omega-3 fatty acids should be consumed at least twice /week. The total daily protein consumption recommendation for people with T2D is the same as the general population (0.86g/kg/day); although there is evidence now emerging that suggests this recommendation should be reconsidered. For example, among

individuals who are obese/overweight (and therefore insulin resistant) a modest increase in protein intake may facilitate weight loss potentially through increased circulating satiety signals such as grhelin, cholecystokinin and glucagon-like peptide 1 (Tremblay et al., 2007).

The proportion of energy intake from carbohydrates should range from 50 – 60% and should be from a variety of foods such as grain products, vegetables, fruits, legumes, milk products and added sugars; however, added sugar should not exceed 10% of the 50-60% of energy derived from carbohydrate. The amount and source of carbohydrate should also be considered and in doing so they promote the consumption of low Glycemic Index (GI) foods more often in order to optimize blood glucose control. Despite the clear recommendations in the Clinical Practice Guidelines and good evidence from clinical and epidemiologic studies suggesting that a low-GI diet may prevent the development of T2D and help to improve glycemic control, there are very few studies that have provided details of an effective framework for increasing the consumption of low-GI food and/or the translation of this evidence into a 'real world setting'.

We have previously had success in helping people with T2D increase both the quantity and quality of their daily physical activity, another behaviour that is integral in the treatment of this disease (Johnson et al., 2006; Tudor-Locke et al., 2002). To this end, the programs we have used, known as the First Step Program and Picking up the Pace, are based on Bandura's (1977) Social Cognitive Theory (SCT) and use simple messages to 'walk more' or 'walk faster', combined feedback and monitoring tools (a pedometer and a stopwatch). While no dominant behavioural theory has been ascribed for MNT (Achterberg & Miller, 2004), in general, nutrition interventions utilize cognitive

behaviour therapy and often employ some aspect of Social Cognitive Therapy (Contento et al., 1995). According to The Social Cognitive Theory (Bandura, 1977) relationships between environment and people help to determine their behaviours. This provides a theoretical framework to help explain how individuals acquire and maintain certain behavioral patterns. Programs that incorporation of Social Cognitive Theory or components of this theory (i.e. self-efficacy) have proven to be effective for increasing physical activity among people with diabetes participating in behavioural interventions (Allen, 2004). Based on the previous success of the implementation of this theory, Social Cognitive Theory (SCT) was selected as the guiding theoretical framework for our Basic and Enhance programs. In our programs, important goals include: to inform our participants of the health risks and benefits of different lifestyle habits as they relate to T2D; create the self-management skills needed to translate health information into healthy lifestyle behaviors; build a stronger sense of self-efficacy to support newly adopted behavioural control when difficulties or barriers surface; and enlist social supports for desired personal changes (Bandura, 2002; Glanz et al., 2002).Hence, we adopted this behavioural strategy with the aim of generating a meaningful reduction in dietary GI. Our approach was based on the assumption that foods with a lower GI could be properly identified and subsequently consumed and that these behaviours would be dependent on the acquisition of the basic concepts, knowledge and skills associated with the concept of the GI.

The current Clinical Practice Guidelines from the CDA promote the consumption of low-GI foods more often in order to optimize blood glucose control. They also provide simple learning resources designed to improve knowledge of the concepts of the

GI (www.diabetes.ca; A new way of looking at carbs). We incorporated these resources into our lifestyle program. We created two separate programs (Basic and Enhanced) and each was designed to be practical to deliver and flexible as we assumed the knowledge of the fundamental concepts and principles of the GI would not be homogenous in the T2D population. Beyond the fundamental educational concepts provided, we tested two separate approaches for goal setting and monitoring of GI consumption. For the Basic approach, the knowledge and skill-based objective was to identify and to simply increase the number of low-GI foods consumed. In contrast, the Enhanced approach centered on the concept of exchanging high-GI foods with low-GI foods as is suggested in the current literature (Brand-Miller and Foster-Powell, 1999). We hypothesized that adults with T2D who followed our Enhanced lifestyle program for 12 weeks would consume a lower GI diet and would achieve more favourable metabolic outcomes, particularly A_{1c}, compared to those who followed our Basic lifestyle program. Many different methods for assessing diet quality exist (Waijers et al., 2007); however, none to our knowledge are geared towards the assessing the quality of carbohydrate food selection after using CFGHE and the Glycemic Index. Thus, in order to better understand the extent of dietary changes undertaken by subjects in this study, we characterized dietary intake of participants after the formal education programs using multiple methods of dietary quality assessment.

5.2.0 Research design and methods:

Details of recruitment and study coordination have been given elsewhere (Johnson et al, unpublished data). Briefly, participants with T2D were recruited through a local advertisement campaign (television and newspaper). Eligibility criteria included:

40 – 70 years of age, not taking insulin, without physical limitations that would limit walking, not currently enrolled in other research studies, no gastrointestinal disorders, and previous completion of at least one diabetes education course. Evidence of self-reported cardiovascular history at prescreening was considered a contraindication to study participation. The study protocol was approved by the Health Research Ethics Board at the University of Alberta. Forty-four individuals with T2D agreed to participate in the study.

The intervention consisted of 2 separate 12-week phases. The first 12 weeks (phase I) was a run-in period and was adapted from a previously developed and evaluated lifestyle program designed specifically for people with T2D (Tudor-Locke et al., 2002). Briefly, the goal for all participants in the first phase was to increase their number of steps/day through a facilitated behavioural modification process. No dietary education was provided during phase 1.

At the end of phase 1 (week 12), participants were randomly assigned to either a basic (Basic) or enhanced (Enhanced) lifestyle program for phase 2 which lasted for another12 weeks. Both of the programs in phase 2 were based on Social Cognitive Theory and included principles of goal setting, self-monitoring and feedback in combination with ongoing evaluation of behavioural self-efficacy (Bandura et al., 1977). The programs were also both designed to use readily available educational resources and tools for behavioural monitoring and feedback, to be simple to implement and practically based. For physical activity, the Basic program followed the same goals for walking as in phase 1 (i.e. increase total daily steps); however the Enhanced group were encouraged

to walk faster on 3 days/week for 30mins. This recommendation was based on previous pilot data (Johnson et al., 2006).

The nutrition education for the Basic and Enhanced program was taught during the first two weeks of phase 2 during group meetings lead by the research coordinator who had extensive experience in nutrition education. In the initial meetings, the concepts of the GI were introduced using a brief presentation and print material from the Canadian Diabetes Association which included "The Glycemic Index" and the "Glycemic Index Explained" (Canadian Diabetes Association – A new way of looking at carbs. http://www.diabetes.ca/Section_About/glycemic.asp and http://www.diabetes.ca/files/Diabetes_GL_FINAL2_CPG03.pdf). At the group meetings, low-GI snacks were introduced and participants were encouraged to further seek low-GI recipes and meal ideas on their own and to discuss these in the following group meetings.

The nutritional monitoring and goal setting strategies served to separate the Basic and Enhanced groups. Since the principles of dietary goal setting and feedback monitoring were important in relation to the GI, each individual was given the task of setting their individualized dietary behavior GI goal. As a starting point, all participants were provided with the average number of low-GI foods they consumed based on their 3-day food records which were collected at the beginning of phase 1. Based on this assessment, they were encouraged to set their own goals for increasing or the number of foods with a lower GI value (i.e. <55) that they would consume on a daily basis. All sessions were lead by the Study Coordinator. The total time of instructor contact was identical between the 2 groups (Basic and Enhanced); each dietary information session lasted approximately 30 minutes and this was followed by a walking session where

participants were encouraged to walk for 30min. Over the course of the intervention period, all subjects were asked to monitor, record and evaluate their food choices based on the knowledge and skills they were provided during the core group sessions. A log book was provided allowing for the recording of the number low-GI food choices along with their number of steps.

For the Basic group, a pocket sized, laminated check-list was used to serve as a dietary intake feedback tool. The card, know as the 'GI-track', (Appendix H) was designed to be compact so that participants could carry it with them at all times. Participants were asked to place a check mark on the card whenever they ate a low-GI food. At the end of the day, they counted the number of check marks and transferred this value into their lifestyle log. The 'GI-track' was then wiped clean for use the following day.

For the Enhanced program, a primary dietary goal was provided by the investigators whereby participants were asked to focus on exchanging at least 2 high-GI foods with 2 low-GI foods on at least 3-days/week (previous pilot data indicated increasing the number of low-GI food servings by this amount was feasible (unpublished data). This approach is consistent with what has been recommended in the literature (Brand-Miller & Foster-Powell 1999)). Participants were further encouraged to select 3 days/week to focus on the quality of their carbohydrate food choices and these days were deemed "GI-days". They were encouraged to set a goal for the number of exchanges they wanted to achieve on those 3 days. The exchanges were to be recorded on their GI-card (Appendix F) at the time that they made their exchange and later recorded in their resource manual for monitoring and feedback purposes. At the time of recording their

carbohydrate food choices, participants were asked to score their exchanges as 'good, better or best' (Brand-Miller & Foster-Powell 1999). The scoring system was: 2 exchanges received a good rating, whereas 3 or 4 exchanges were rated as 'better' or 'best' respectively. For example, if a participant consumed white bread (GI = 70) at breakfast and a baked potato (GI= 78) for dinner, they would exchange these with whole grain pumpernickel (GI= 46) and steamed brown rice (GI= 50) this was recorded as a 'GOOD GI day'. Achieving high task self-efficacy for identifying low-GI and high-GI foods was considered an essential component of the intervention. At the end of each week, participants tallied the quality of their 'GI-days' and evaluated the quality of those days based on the good, better or best goal they had set.

During phase 2, all participants in their respective groups (Basic and Enhanced) attended one weekly lifestyle meeting/week for 4 weeks and each week included a supervised walking session (weeks 13-16) along with training on making the dietary changes. From weeks 17-20, they attended 2 weekly booster sessions and during weeks 21-24 they attended one booster session where a 30 min group walking session was held. No formal instructions for diet or walking were provided at these booster sessions.

Anthropometric and laboratory measurements were completed at baseline, 12 weeks (end of phase 1), and 24 weeks (end of phase 2) at the Human Nutrition Research Unit, University of Alberta, Canada. Hemoglobin A_{1c} was measured using a an autoanalyzer (DCA 2000®+ (Bayer Inc., Toronto, ON, Canada). Resting heart rate and blood pressure were measured using a digital sphyngomanometer (Quick Response, LifeSource™, model UA-787, San Jose, California, United States) and reported as the average of 3 consecutive measurements separated by 3-5 mins. Body weight (Stand-on-

Scale, Seca 220) and height (QuickMedical, Heighttronic™, Snoqualmie, Washington, United States) along with waist and hip girth (non-stretch Teflon™ tape) were measured with participants wearing a standard hospital gown with no shoes or stockings. All measurements were taken in triplicate and averaged.

Each participant was instructed on how to record dietary intake using 3-day food records, how to use their pedometer (Yamax, SW 200, Tokyo, Japan) and how to record their steps/day and food choice changes as previously described (Tudor-Locke et al., 2004). Dietary data were analyzed using Food Processor Nutrient Analysis Software v. 9.9.0 (ESHA Research Salem, Oregon, USA). Average daily glycemic index (GI) and load (GL) (Willett et al., 2002) were calculated from published tables (Foster-Powell et al., 2002) with additional information retrieved from an online database (www.glycemicindex.com).

A global carbohydrate score was derived from the 3-day food records as an additional way one way, in addition to examining nutrient intake, to examine the quality of dietary intake. The global carbohydrate score was based on 7 carbohydrate-containing components of the most recent version of CFGHE and included: 1) whole grains, 2) refined grains, 3) fruit, fruit juice, 4) vegetables, vegetable juice, 5) dairy products, 6) pulses and legumes and 7) food 'to be consumed less often'. A partial score ranging from 0 to 4 was assigned to each category except the juices category which received a maximum score of 1. The total score could therefore range from 0 to 30. A total score of 30 would indicate a high quality carbohydrate diet and would represent a higher consumption of whole grains, fruits, vegetables and legumes.

Milk and alternative dairy products are important sources of calcium, vitamin D, magnesium, phosphorus, protein along with contributing carbohydrate and fat to the diet. Canada's Food Guide to Healthy Eating recommends 2 servings/day for adults and suggest this can be achieved by consuming 2 cups (250 ml) of milk. Consuming less than 2 servings might therefore limit the intake of these important nutrients and therefore fewer points were given for not reaching this minimum amount per day. Conversely, although lower fat choices are recommended such as non-fat, 1% and 2%, the food guide lists other examples of milk and alternative dairy sources that are not low in fat (i.e. homogenized milk). Higher fat milk and alternative dairy sources may contribute to a higher fat dietary that exceeds recommended levels and undermine some positive health outcomes such as weight loss and/or maintenance. Again, a lower score was given to people's diets if more than 2 servings of any dairy product was consumed. The highest score was given for moderate dairy consumption.Thus, consuming more than 2 servings/day of high fat dairy may contribute to increased weight gain and disease risk. The highest score was given for moderate dairy consumption. A lower score represents a higher consumption of refined grains, lower in fruits and vegetables, high or low consumption of dairy and a higher consumption of 'foods to be consumed less often'. The 'foods to be consumed less often' were based on the total number of servings over the 3 day collection period (not an average) and a higher score was given for less frequent intake. Further details of the scoring system are provided in Appendix I.

A two-way analysis of variance with repeated measures was used to test for differences between groups for all clinical and dietary outcome variables. A consistent trend indicating changes for both groups over time with no interaction was found for the

dietary variables; therefore, further one-way repeated analysis of variance with repeated measures based on the pooled data from all participants was completed to examine changes in clinical outcomes, food choices, dietary patterns, GI and GL over time. Correlation analyses (Pearson product moments) were used to examine the association between observed changes in total energy intake and body weight as well as GI and glycemic control. All descriptive data and statistical tests were completed using SPSS software for Windows Version 15.0 (Chicago, Illinois, USA)

5.3.0 Results:

Thirty – seven participants completed phase 2 of this intervention and complete data (both pre and post-intervention) for dietary intake was available for 33 participants; 4 participants did not return their 3-day food records. The mean age was 57.8 ± 6.7 years; body weight 90.3 ± 22.8 kg and a mean BMI of 32.3 ± 6.5 kg/m^2. Other health indicators are reported in Table 5.1.

At the end of phase 2, a significant reduction in body weight (Δ = 1.6 ± 1.6kg, p< 0.001), BMI (Δ = 0.6 ± 0.6kg/m^2, p< 0.001) and hip circumference (Δ = 1.4 3.1cm, p= 0.2) was achieved. The majority of participants lost weight (n = 27, 85%) and among this group who lost weight, nearly half (n= 11, 41%) lost ≥ 2.5% of their body weight and this included 3 participants (11%) who lost > 5% of their original body weight at the end of phase 2. There was no change in A_{1c} (Δ = 0.05 ± 0.3%, p = 0.41) or systolic blood pressure (Δ = 3.9mmHg ± 12.0, p= 0.06) while there was a modest increase in diastolic blood pressure (Δ = 3.3 ± 7.7 mmHg, p= 0.02).

No dietary changes were detected during phase 1 of this study (unpublished data) and no significant group x time interactions for any of the diet variables assessed over the

course of phase 2 were found therefore dietary data from all subjects (n=33) were pooled. Table 5.2 shows dietary intake of total energy, macronutrients, average daily GI and GL and total dietary fibre at the end of phase 1 and the change in their intake at the end of phase 2. At the end of phase 2, both GI and GL were reduced (p= 0.03 and 0.007, respectively), while the intake of dietary fibre remained unchanged (p= 0.26). It should be noted that the people in the Basic group tended to increase their dietary fibre when compared to the Enhanced group however there was no statistically significant group by time interaction (p= 0.06). .A significant reduction in total energy (p= 0.01), total carbohydrate (p= 0.03) and total fat intake (p= 0.03) were observed after phase 2 across all subjects.

As shown in table 5.3, the number of servings of whole grains increased over the course of Phase 2 by nearly one whole serving (Δ = +0.7 ± 1.8, p= 0.04) with a reduction in the number of servings of refined grains (Δ = -0.7 ± 1.7, p= 0.04). A statistically significant increase in the number of servings of pulses and legumes improved (Δ = +0.2 ± 0.6, p= 0.05. On average, participants reported consuming approximately 1 less serving of dairy products/day at the end of the study compared with at the end of phase 1 (Δ = -0.7 ± 1.1, p= 0.002). Similarly, both groups reduced the number of servings selected from the foods 'to be consumed less often' category by one and a half servings/day (Δ = -1.5 ± 3.7, p= 0.03). Despite the observed changes in servings described above only the pulse/legume category showed significant improvement. The global carbohydrate score did not change significantly over time (14.5 ± 3.6 to15.4 ± 3.2, p = 0.13).

Table 5.4 shows the proportion of individuals meeting the current guidelines for carbohydrate-based food categories, relative to CFGHE, according to age and sex at the start and end of phase 2. At the end of phase 1, less than one quarter (21%) of participants met the current guidelines for fruit and vegetable intake and over half (52%) met the recommendations for milk and dairy while more than three-quarters (76%) met the recommendations for meat and alternatives. Following the intervention (at the end of phase 2), approximately half (42%) of the participants met the current guidelines for fruit and vegetable intake and approximately one-quarter met the recommended number of servings for milk and dairy (25%) while just over three-quarters (76%) of the participants met the recommended number of servings for the meat and alternatives group at the end of both phase 1 and 2 respectively.

At the end of phase 2, the change in average daily GI (Δ) was positively and significantly associated with the final A_{1c} ($r= 0.477$, $p= 0.005$), however no association was detected for A_{1c} and the average daily GI at the end of phase 2 ($r= 0.263$, $p= 0.141$). Following phase 2, there was a positive association between total caloric intake and GI ($r= 0.36$, $r = 0.04$). However, no association was detected for the observed reduction (change score) in caloric intake and GI ($r = 0.20$, $p = 0.26$).

A significant inverse association was detected between the number of servings of whole grains and A_{1c} at the end of phase 2 ($r= -0.343$, $p= 0.05$) while no association was found for the number of refined grain servings and A_{1c} ($r = 0.229$, $p= 0.20$). At the end of phase 2 body weight was positively associated with total energy intake ($r= 0.446$, $p= 0.01$).

5.4.0 Discussion:

Evidence from epidemiologic and controlled clinical investigations suggest that among people with T2D, increased consumption of foods with a low-GI (typically below 55) and/ or low Glycemic Load (GL) are associated with reduced postprandial blood glucose, hemoglobin A1c (A_{1c}) and cardiovascular disease risk factors, namely: serum TG and HDL-C (as reviewed by: Kalergis et al., 2005, Brand-Miller et al., 2003; Ludwig, 2002). The results of the current study showed that a lifestyle intervention that targeted the GI lead to a relatively small, though statistically significant, reduction in daily average GI and total daily GL. These small changes are important because of the low average daily GI reported by people at the end of phase 1. It has been suggested that the GI of the diet among free living individuals with T2D is highly variable and is approximately 85 units (Wolever et al., 1992) while prospective cohort data has shown that GL generally ranges from approximately 120 to 150 units (Hu et al., 2000). Thus, the average daily GI and GL scores found in this study might be considered to be very good (or very low), and it is interesting that a simple program that targets this single aspect of the diet can further increase the intake of low- GI foods.

Despite the reduction in GI observed in this study, no changes in glycemic control were detected after 12 weeks. It has been suggested that the GI of the diet must be reduced by 15 units (Brand et al, 1991) for clinically meaningful improvements in glycemic control to occur, and that in order to achieve this improvement in carbohydrate quality (a reduction of GI by 15 units), a behavioural approach that focuses on the exchange of high-GI with low-GI carbohydrate foods will facilitate improved glycemic control while not limiting the number of palatable food choices (Brand-Miller & Foster-

Powell, 1999). Participants in both groups from this study reduced their GI by the less than 15 units; however, they consumed more servings of whole grains and fewer servings of refined grains. This is a positive change in food choice behaviour, which is further borne out by correlation analyses confirmed that the number of servings of whole grains was associated with improved glycemia across all participants at the end of the intervention period. This result suggests improved glycemic control was closely related to the consumption of better quality carbohydrate. This has particularly exciting implications in light of the fact that the majority of the individuals that participated in this study had very good glycemic control.

A dietary pattern that is characterized by an intake of vegetables, fruits, and unprocessed grains in quantities that meet CFGHE is generally recommended for people with T2D. Interestingly, this study found few individuals met the recommended numbers of serving outlined by CFGHE yet they still had a low-GI diet: this is an intriguing result since our programs began with fundamental nutrition knowledge followed with basic GI information. It is plausible that individuals were attempting to lose weight (although this was not promoted) and therefore they were not meeting the recommendations based on CFGHE and while doing this they were still making food choices that were appropriate and consistent with our message to consume low-GI foods.

Strong evidence suggests intensive management programs incorporating lifestyle modification, particularly diet and physical activity, can lead to positive metabolic outcomes, especially among those in a pre-diabetic state (i.e. impaired glucose tolerance or impaired fasting glucose) (Hadden; et al.,1975; Pan 1997; et al., Knowler et al., 2002; Tumilehto et al., 2001). These positive clinical outcomes, however, were largely

predicated on behavioural modification. For example, the US Diabetes Prevention Program (DPP) showed that after an intensive lifestyle modification program focusing on diet and physical activity with the aid of personalized management for diet and physical activity lead to a 58% reduction in the number incident cases of diabetes compared to a placebo control group over a 3 year follow-up period. This approach has been widely adopted and accepted as an effective approach for those who have been diagnosed with T2D. But beyond this type of intensive approach for T2D management, how best to help people maintain a healthy lifestyle at any time of their life is an unanswered question.

The current CDA-CPGs recommend a 5-10% reduction in body weight over 6 months (CDA, 2003) which should be approached through a reduction in energy intake and increased energy expenditure. The participants in this study achieved a 2% reduction in body weight on average after only 3 months. The observed reduction in total caloric intake was modest but significant and most likely contributed to the observed weight loss. The reduction in total caloric intake likely resulted from a reduction in the number of servings from foods in the 'consume less often' category and/or a reduction in the number of servings from the milk and dairy category both contribute fat and carbohydrate. Foods from the 'consume less often' group are typically higher in fat and refined carbohydrate; therefore, the observed reduction in energy intake from total fat was likely due to the reduced number of servings from this category but also from the milk and dairy since milk and dairy products also a source of dietary fat.

In terms of weight loss, it is interesting that although on average participants did not achieve the weight loss recommended by the CPGs, nearly half had achieved at least a 2.5% reduction in body weight after 12 weeks. Thus, from a practical perspective, our

results suggest the framework we used serves as a vehicle to improve, or at least, sustain modest improvements in body weight in this group of patients. This is often a clinical goal for people with T2D.

Preliminary data from the Look AHEAD trial (Pi-Sunyer et al., 2007), a large multi-center randomized controlled trial in people with T2D that was modeled after the DPP, has shown that after one year of intensive lifestyle management, individuals with T2D lost nearly 9% of their initial body weight while those in the control group (usual care) lost less than 1%. The improvement in body weight in the treatment group, when compared to the control group, was achieved through decreased caloric consumption and increased energy expenditure. The study has also shown that, after one year, approximately 25% more individuals achieved an A_{1c} of less than 7% (46% at baseline to 73%). The dietary intervention for the Look AHEAD trial, like the DPP, is highly structured and resource intensive and includes group and individual contact with a dietitian accompanied by structured meal plans and meal replacement products among many other tools and strategies. The objective of our study was to provide a less intensive structure for lifestyle management. We provided straightforward messages and basic feedback tools along with minimal contact with study staff and no individualized counseling. Although the weight loss observed in this study in not of the same magnitude as the preliminary data from the Look AHEAD trial, the overall ~ 2.0% reduction in body weight we observed along with the correlation between body weight and energy intake at the end of phase 2 suggests that both of our approaches can lead to positive changes in diet and a reduced body weight after only 12 weeks.

Clinical outcomes often overshadow behavioural outcomes. For example, healthcare providers primarily focus on tight glycemic control (Knight et al., 2006). But because many other important metabolic outcomes (i.e. weight or cardiovascular risk) are directly linked to behaviours like poor nutrition and physical inactivity, the monitoring and achievement of behavioural outcomes have important implications and need to be considered equally within the context of lifestyle management for T2D (Wing et al, 2001). Although we did not see a reduction in A_{1c}, the fact that there was no significant increase over 12 weeks is clinically meaningful. Moreover, because these participants were in good glycemic control to start with, an increase in A_{1c} may have been more likely. Thus, given the relatively modest improvements in clinical outcomes observed in this study, important follow-up questions include: how long can dietary changes can be sustained and if sustained, what are the long-term implications of these changes?

We provided basic nutrition information as a foundational principle in our nutrition intervention. Savoca et al, (2001) recommend that a starting point for all goal-setting dietary interventions should include concepts related to basic eating practices especially among those who may have difficulty with disease management and are resistant to dietary change. Our results suggest that even in patients who may not be experiencing difficulty with disease management and who appeared motivated, starting with fundamental nutrition principles was appropriate because improvements in dietary intake were observed.

The framework for the basic nutrition portion of our intervention was consistent with CFGHE. In doing so, an emphasis was placed on the food groups containing the greatest proportion of dietary carbohydrate/serving and participants were encouraged to

set goals and select low-GI foods while using CFGHE as a basis for meal planning. Our results suggest that relative to the CFGHE the dietary patterns participants were not meeting the recommended number of servings of the food groups containing dietary carbohydrate. This result was further confirmed by our carbohydrate score which was generally low. Nevertheless, we did observe increased consumption of pulses and legumes and a reduction in the number of servings from the foods 'to be consumed less often' category. Thus, CFGHE appears to have played an important role for helping people when identifying and selecting foods of higher nutritional value in combination with the concept of GI.

Our data suggests that a theory based approach to changing dietary intake facilitated positive changes in the selection of lower-GI foods. Current evidence delineating the mediators and moderators of dietary self management for T2D is limited. Some suggest eating patterns are most often influenced by good knowledge of diet in relation to disease management (Savoca & Miller, 2001), and that dietary self-efficacy for food selection and eating patterns, social support and time management (planning) are strong mediating variables that can influence dietary behaviours among those with T2D. We hypothesized that the design of our lifestyle intervention provided sufficient information to support increased knowledge. We posited that the provision of basic GI information would lead to increased self-efficacy and a positive change in diet patterns (i.e. selection of more low GI foods). Although no definitive behvioural theory has been identified for guiding dietary change (Achterberg & Miller, 2004), according to Baranowski and colleagues (2003), basing a behvioural intervention on constructs derived from any behavioural theory is more beneficial than not including any

behavioural theory. Our data would suggest that incorporating constructs from Social Cognitive Theory such as goal setting and self-monitoring lead to modest improvements in GI and GL, but because we did not set out to explicitly test the Social Cognitive Theory, we can not conclude that this theory is preferable for improving dietary GI or GL in this population.

5.5.0 Conclusion:

Here we have shown that a relatively straightforward lifestyle intervention that targeted low-GI foods may be an effective approach for helping people with T2D modify their own dietary habits. Moreover, these positive behavioral changes were associated with a reduction in body weight and helped to maintain good glycemic control. Managing T2D is a complicated task for both healthcare professionals and those with the disease. Our study demonstrates that a simple program that requires minimal resources and which might be easily adopted by clinical and community healthcare settings can lead to positive behavioural and health outcomes in this population.

Table 5.1: Demographic and clinical characteristics after phase 1

Characteristic	
N[†]	33
Female:male	17:16
Age (years)	57.8 ± 6.7
Average time from diagnosis (months)	50.1 ± 50.4
A_{1c} (%)	6.2 ± 0.8
BMI (kg/m^2)	32.3 ± 6.5
Waist circumference (cm)	107.6 ± 18.3
Hip circumference (cm)	112.8 ± 18.3
Systolic blood pressure (mmHg)	120.5 ± 13.4
Diastolic blood pressure (mmHg)	77.5 ± 10.4
Physical Activity (steps/day)	10,891 ± 4,360

- [†] one subject refused all anthropometric and laboratory measures except A_{1c}; all values are reported as mean ± standard deviation

Table 5.2: Daily intake of energy and selected nutrients before and after 12 weeks (Phase 2) of the lifestyle intervention (n=33)

Variable	End of phase 1 (baseline)	Δ	P
Glycemic index (arbitrary units)	50.6 ± 4.9	- 2.3 ± 5.5[a]	0.02
Glycemic load (arbitrary units)	120.1 ± 51.6	- 19.6 ± 38.4[a]	< 0.01
Calories, kcal	2169.1 ± 622.4	- 228.4 ± 495.8[a]	0.01
Carbohydrate, g	267.9 ± 86.9	- 26.7 ± 66.9[a]	0.03
Fat, g	83.5 ± 32.0	- 16.1 ± 40.8[a]	0.03
Protein, g	92.6 ± 22.2	- 3.3 ± 29.2	0.53
Dietary fibre, g	24.7 ± 9.5	+ 1.9 ± 10.7	0.31

All values are reported as mean ± standard deviation; [a] significantly different from the end of phase 1, $p < 0.05$; Delta (Δ) represents the variable assessed at the end of phase 2 subtracted from the variable assessed at the end of phase 1

Table 5.3: Average number of servings reported (over 3 days) in different categories used to derive the carbohydrate score before and after the 12-weeks (Phase 2) of the lifestyle program (n=33).

	Portions		Partial Score*	
Food Categories[†]	End of phase 1	End of phase 2	End of phase 1	End of phase 2
Whole Grains	2.0 ± 1.7	2.7 ± 1.5[a]	1.3 ± 1.0	1.5 ± 0.8
Refined Grains	2.6 ± 1.7	2.0 ± 1.3[a]	2.5 ± 0.9	2.7 ± 0.7
Vegetables	3.8 ± 2.5	3.1 ± 1.5	3.1 ± 1.0	2.8 ± 1.0
Vegetable Juice	0.1 ± 0.3	0.4 ± 0.6	0.1 ± 0.3	0.3 ± 0.5
Fruit	2.4 ± 1.6	2.5 ± 1.6	2.3 ± 1.5	2.3 ± 1.2
Fruit Juice	0.3 ± 0.6	0.4 ± 1.2	0.3 ± 0.6	0.3 ± 1.1
Dairy Products	2.2 ± 1.2	1.5 ±1.0[a]	3.2 ± 1.4	3.2 ± 1.2
Pulse/Legumes	0.1 ± 0.2	0.3 ± 0.6	0.2 ± 0.5	0.5 ± 1.0[a]
Consumed less often[‡]	5.2 ± 3.7	3.7 ± 3.0[a]	1.6 ± 1.1	2.0 ± 1.4
Global carbohydrate score			14.5 ± 3.6	15.4 ± 3.2

All values are reported as mean ± standard deviation; [†] No significant group differences were detected; * See Appendix I for scoring methods; [‡] 3 day cumulative; [a] significantly different from the end of phase 1, $p < 0.05$.

Table 5.4: Percentage of individuals meeting the recommended number of servings from Canada's Food Guide to Healthy Eating before and after the 12-weeks (Phase 2) of the lifestyle program (n=33).

	Food Categories			
	Vegetables & Fruit	Grain Products	Milk & Dairy	Meat & Alternatives
	% (n)			
End of phase 1	21 (7)	12 (4)	52 (17)	76 (25)
End of phase 2	42 (14)	12 (4)	24 (8)	76 (25)

Note: All individuals were compared to the current food guide values based on age and sex

5.6.0 References:

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Chapter 6 - Promotion of Physical Activity by Canadian Registered Dietitians in Daily Practice[1]

6.1.0 Introduction:

Poor dietary habits and physical inactivity are considered important risk factors for many chronic diseases (Appel, 2003; Brown et al., 2003; Castaneada 2003; Byers et al., 2002; Erlichman et al., 2002). Despite the known benefits of physical activity, adults rarely meet general physical activity recommendations required to derive health benefits. Thus, it is important that promoting the numerous benefits to overall health of participating in regular physical activity be made at every possible opportunity.

Dietitians are in an ideal position to promote PA through integrating active living strategies with healthy eating messages. Chapman and colleagues (2005) have suggested when counselling for weight management, dietitians should utilize a lifestyle approach that includes both healthy eating and PA. Hence, qualified dietetics professionals should promote not only healthy eating, but also provide simple physical activity messages in daily practice when appropriate (Barr, 2001).

In 2001, focus groups were attended by dietitians from throughout Alberta, Canada to determine their needs for incorporating physical activity messages as an adjunct to nutrition counselling. Results from the focus groups demonstrated that dietitians felt that they required additional knowledge and training in physical activity in order to promote it effectively (Spidel et al., 2004). An educational workshop was created with the objective of providing dietitians with knowledge, skill development, and

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[1] A version of Chapter 6 is published: Johnson ST, Bates H, Fitzpatrick J, Marshall JD, Bell RC, McCargar L. Promotion of physical activity by Canadian Registered Dietitians in daily practice. J Hum Nutr Diet. 20(1):37-40, 2007

awareness of resources to improve their self-efficacy when promoting active living. Those who attended the workshops (n=110), compared to wait-list controls (dietitians waiting to attend the workshop) significantly improved their knowledge, attitudes and self-efficacy for active living counselling (McCargar et al., 2004). It is unknown whether this knowledge was translated into a change in daily practice.

This study examined whether dietitians who attended an active living workshop were more likely to employ specific strategies to promote active living compared to dietitians who did not attend the workshop. The strategies investigated included the use of stage of readiness assessment, active living resources, active living tools, a referral base for physical activity specialists, and development of care plans with active living components for clients.

6.2.0 Research design and methods:

One year following the workshops, all registered dietitians (RD) in Alberta who could be contacted through a professional electronic newsletter (n=504) were asked to complete a web-based survey (Appendix J). Items included in the survey were grouped into: (1) personal (i.e. age, gender, years in practice and physical activity level) and practice information (i.e. work setting, counselling issues and age groups of clients most often counselled), and (2) counselling strategies related to physical activity/active living. Those who attended the workshop are designated as workshop participants (WP) and those who did not attend the workshop are designated as non-participants (NWP). Approval for this study was obtained from the Faculty of Agriculture, Forestry and Home Economics Human Ethics Review Committee, University of Alberta.

Descriptive statistics, frequencies and cross-tabs statistics were used to evaluate responses. An unpaired t-test was used to examine group differences for continuous variables. Group differences between categorical variables (physical activity counselling characteristics and strategies) were examined using a Chi-square test.

6.3.0 Results:

A total of 103 RD responded to this survey (response rate = 19.1%). Of those who responded, 66 were WP and 37 were NWP. No significant differences were observed between WP and NWP with respect to the demographic characteristics measured (Table 6.1).

Dietitians indicated that the main (>50%) dietetic issues addressed in practice were obesity, diabetes, healthy eating and general disease management. Almost all (90.5%) of surveyed dietitians promote physical activity in daily counselling and almost half (46.7%) indicated they had done so for more than 5 years. Although over half (54.9%) of all respondents indicated they 'never' or 'some of the time' refer clients to PA experts, attending the workshop was associated with significantly more frequent client referrals to physical activity professionals by dietitians (WP = 62.9% vs NWP = 37.5%; χ^2 = 12.68, $p<0.05$; see Table 6.2). Aside from this single difference in counselling strategies, there were no significant differences between the WP and NWP groups with respect to physical activity counselling observed. No significant differences were observed between the groups when using tools such as pedometers, physical activity diaries, or other techniques for physical activity self- monitoring.

6.4.0 Discussion:

The response rate of this study clear limits the interpretation of the results. However, amongst respondents there are clear indications that the promotion of physical activity, as an adjunct to nutrition counseling is widely practiced by dietitians. Numerous tools to promote and support physical activity (e.g., activity diaries and pedometers) are widely available and appear to be commonly used by dietitians who responded to our survey. Attendance at a workshop designed to help dietitians incorporate active living into their counseling practice was associated with a greater number of participants making use of physical activity professionals for client referrals. Increased awareness of physical activity -related partners and professionals within the community, as was promoted in the workshop, could support the promotion of a partnership with physical activity professionals. Alternatively, increased partnerships may also reflect practice issues such as lack of time to counsel both nutrition and physical activity or the needs of specific clients requiring advanced physical activity information beyond basic public health messages. Regardless of the reason, those who attended our workshop have been establishing linkages with another important group of health professionals, i.e., those with expertise in physical activity.

6.5.0 Conclusion:

Physical activity counselling is within the scope of dietetic practice. Registered dietitians in Alberta, Canada promote physical activity and attending a workshop designed to facilitate the use of specific tools and strategies for promoting physical activity in daily practice resulted in increased referrals of their clients to physical activity specialists.

Results of this study further strengthen the connections between healthy eating and active living.

Table 6.1: Demographic characteristics and self-reported physical activity behaviours of surveyed dietitians, stratified by workshop participation[a,b]

	WP[c]	NWP[d]
N	37	66
Age (years)	38.7 ± 10.2	38.2 ± 10.3
Years as Registered Dietitian	13.0 ± 8.6	12.5 ± 10.8
Physically active (%)	97.3	97.0
Physical activity > 3 times per week (%)	86.1	76.6
Promotes physical activity (%)	94.6	86.4

[a]Female to male ratio 102:1, [b]mean ± standard deviation, [c]WP-workshop participants, [d]NWP- non-workshop participants

Table 6.2: Active living counseling strategies of dietitians

	Response (%)			
	Never	Some of the time	Most of the time	Always
Assessed readiness for active living				
WP (n=35)	8.6	37.1	45.7	8.6
NWP (n=55)	10.9	41.8	29.1	18.2
Active living strategies based on stage of change				
WP (n=35)	5.7	37.1	45.7	11.4
NWP (n=56)	8.9	44.6	32.1	14.3
Incorporated active living tools (i.e. activity diary)				
WP (n=35)	14.3	42.9	20.0	22.9
NWP (n=56)	32.1	41.1	8.9	17.9
Developed active living care plan				
WP (n=35)	11.4	31.4	42.9	14.3
NWP (n=56)	8.9	39.3	33.9	17.9
Incorporated Canada's Physical Activity Guide				
WP (n=35)	5.7	45.7	20.0	28.6
NWP (n=57)	17.5	36.8	19.3	26.3
Recommend PA tools (i.e. pedometers)				
WP (n=35)	2.9	45.7	34.3	17.1
NWP (n=56)	21.4	42.9	17.9	17.9
Referral to PA professional*				
WP (n=35)	37.1	42.9	17.1	2.9
NWP (n=56)	62.5	12.5	14.3	10.7

* significantly different ($\chi^2 = 12.68$, $p<0.05$)

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Chapter 7 – Summary and Conclusions

7.1.0 Introduction:

There is little doubt the incidence of T2D will continue to increase. To address this, consideration of lifestyle, particularly diet and physical activity, are important targets for prevention and the current literature supports this. Although a strong body of evidence emphasizes the health benefits of lifestyle modification for people with T2D, very little information is available regarding the effectiveness of primary care or community based strategies for achieving the lifestyle modification necessary to acquire health benefits. Thus, designing and evaluating lifestyle programs that foster positive self-management leading to greater sustainability for patients and the health care system are necessary.

Generally speaking, lifestyle management of T2D targets improved glycemic control and a reduction in the risk of complications, while minimizing short term hypoglycemia. There is evidence demonstrating the positive effects of lifestyle modification for improving health outcomes, particularly glycemic control and weight reduction, among individuals with T2D. Much of this evidence was generated from highly intensive lifestyle interventions that might be considered a 'best-case-scenario' which included specialized consultation with health care providers on an individual basis and therefore less likely to be practical or applicable to the current health care model.

Research conducted as part of this thesis was intended to be practical and sustainable if implemented in a current health care setting. To this end, individuals were provided with basic dietary and physical activity knowledge and skills and were encouraged to modify their behaviour through individualized goal setting, and simple

monitoring. Monitoring tools were used to provide objective feedback, thereby helping individuals understand their own behaviours and make changes to their goals. The overall aim of this research program was to gain further insight into the physical activity and dietary intake behaviours characteristic of individuals with T2D after participating in lifestyle modification programs and from this, was to design, test and assess the effectiveness of a lifestyle modification program. Despite the provision of specific dietary and physical activity recommendations for T2D management in the Current Clinical Practice Guidelines, no best-practices or programmatic frameworks have been outlined to support individuals with T2D and their health care providers. Thus, the knowledge gained from this body of research was also intended to be translated to health professionals like dietitians who are in an ideal position for promoting healthy lifestyles and who often require effective strategies to facilitate lifestyle modification.

7.2.0 Study conclusions:

Study # 1

The median walking speed among a group of adults with T2D was 3.3 km/h and thus did not meet the walking speed commonly accepted as moderately intense physical activity as outlined by the current Clinical Practice Guidelines. The results agree with our hypothesis. The low walking speed observed in this study suggested that health benefits of walking may not be fully achieved, even though participants approximated the popular volume recommendation of 10,000 steps/day.

Study # 2

As hypothesized, a pedometer and a stopwatch can serve to facilitate increased walking intensity in people with T2D and improve cardiorespiratory fitness when introduced within an educational framework designed for increasing daily physical activity.

Study # 3

The main finding from this study was that among a group of people with T2D, participation in a lifestyle intervention with a progressive physical activity component that incorporated a goal of walking faster on 3 days/week, 30mins/day in addition to walking more than at baseline lead to improvements in cardiorespiratory fitness as measured by resting heart rate. As we hypothesized, this improvement in RHR was greater than that observed in a group walking the same number of steps without instruction to walk faster.

Study # 4

The daily average Glycemic Index and total daily Glycemic Load did not differ between the basic and enhanced lifestyle groups. However, after pooling data from both groups a relatively small, though statistically significant, reduction in daily average Glycemic Index and total daily Glycemic Load was detected.

Study # 5

As hypothesized, attendance at a workshop designed to help dietitians incorporate active living into their counseling practice was associated with a greater number of participants making use of PA professionals for client referrals and that the

promotion of physical activity, as an adjunct to nutrition counseling is widely practiced by dietitians. Results of this study further strengthen the connections between healthy eating and active living.

7.3.0 Summary:

Simple messages like walking 10,000 steps/day have been widely accepted as a reasonable daily physical activity goal. The pedometer is a basic tool that provides real-time, objective feedback about daily physical activity. This tool may help to motivate people in achieving a volume-oriented stepping/walking goal. This thesis has shown that the knowledge (benefits of walking for T2D) and skills (how to wear and record daily steps) necessary to achieve a volume goal like 10,000 steps/day are easily transferable and help people with T2D walk faster. The addition of a second pedometer and a stop-watch, along with a program that provided an opportunity for skill development and practice, to fostered a new behavioural target for physical activity for this population. Thus, the message to 'walk faster' that was used in this research provided a practical way to help people interpret the current public health recommendation to 'walk briskly'.

This research also showed that the progression to more intense physical activity can be approached with a pedometer by first increasing the total number of steps taken each day followed by an increase in the number of steps taken over a specified time frame to elicit a positive physiological outcome (improved cardiorespiratory fitness and reduction in body weight) is acceptable. This is an important finding because not only is the adoption of healthy behaviours important for people with T2D but the maintenance of these behaviours in free living conditions (i.e. away from a clinical setting) is integral for reducing the risk of long term CVD complications. We have shown that our program is

unique in that it facilitated both the adoption and maintenance of physical activity over a longer term (6 months) which is an important new finding and will add to the current literature since most pedometer based studies in this population have been short term.

Based on the results of this research, our approach to T2D lifestyle management was effective. The people in our lifestyle program walked more and then they walked faster, they reduced their caloric intake and they reduced their intake of higher Glycemic Index foods; therefore, from a lifestyle perspective, this study was highly successful. Furthermore, because over 6 months they also continually lost weight, they reduced their blood pressure and those in the Enhanced program improved their level of fitness, our program can therefore also be viewed as successful from a physiological perspective.

Our approach to T2D lifestyle management is convincing in that we showed positive behavioural and clinical outcomes. Since these studies were conducted in a practical setting with limited resources, further research will be required but the approach is likely to be applicable to many sites across the country.

This research has also shown that following a workshop designed to promote physical activity as an adjunct to nutrition counseling, dietitians were incorporating numerous tools to promote and support physical activity (i.e. pedometers). This workshop also informed dietitians about physical activity specialists in their community and because of this they were more likely to refer their clients to these specialists when compared to dietitians who did not attend the workshop. These results are important because it shows that dietitians are willing to engage physical activity specialists when promoting physical activity. Importantly and related to this program of research it appears dietitians are promoting physical activity using basic tools like pedometers and

thus they may be in an opportune position to promote a basic message like 'walk faster', similar to the approach used in this program of research.

7.4.0 Future Research:

This research demonstrated that a program that incorporated direct messages, available resources, and easy-to-use tools was effective for promoting lifestyle behaviour change. Future research using this approach needs to be examined. The following are suggestions for research directions that may be followed to build on the knowledge gained from the current research:

(1) Since this program has proven to be relatively successful, the addition of a new and basic message to 'walk faster' might be considered for a public health campaign for disease prevention. The public health campaign 'Canada on the Move' was initiated to promote pedometer use and has been shown to be effective for increasing daily physical activity (Craig et al, 2007). The use of pedometers and a motivational health-related message was associated with increased odds of walking. Therefore Canada on the Move might be an appropriate entry point for the message to 'walk faster'.

(2) A large scale multi-centre trial to examine the efficacy of the approach used in our Enhanced program is warranted. A study comparing the approach of the DPP (i.e. low-intensity vs. intensive management) to the approach used in this study with a longer term prospective design would allow for the assessment of micro and macro vascular outcomes. Since our group was well controlled a larger study of

this nature would also allow for sub-group analysis among those with poor to moderately good glycemic control. This would provide new information about the efficacy of this type of lifestyle program and the magnitude of effect it may have on glycemic control.

(3) The design of our randomized controlled study program was progressive in nature. The first 3 months were modeled after the First Step Program (Tudor-Locke et al., 2004) and was used to help people to become more physically active. This approach provided the development of knowledge and skill to build self-efficacy which provided a platform for the 'Next Step' to address the intensity (speed) of walking. This approach could be taken with a new program as a follow-up. The follow-up program would integrate the same theoretical framework in that it would provide a basic message tied to the supporting skills and knowledge to accomplish a behavioural goal The First Step Program, Picking Up the Pace and Healthy Eating and Active Living for Diabetes have proven to be efficacious for realizing their intended behavioural targets among people with T2D (i.e., increasing walking volume and intensity). Although not measured, it is possible that people enrolled in our programs have experienced improvements in other physical/motor parameters that could contribute to an improved overall quality of life. For example, being more active through walking may have also lead to improvements in strength, stamina and/or flexibility. Improved strength and/or flexibility are known to greatly improve quality of life (Kell et al., 2001) and improved functional capacity, which may be important to individuals with T2D. Thus, future studies should include assessment of additional outcomes

including flexibility and/or functional capacity to understand the extent to which they may mediate the effectiveness and efficacy of physical activity related interventions. Future studies should also consider including a strength/resistance training or a stretching/yoga/pilates component in order to specifically address these issues.

(4) Behaviour modification is a complex endeavour and any number of psychosocial moderators and mediators contribute both positively (facilitators) and negatively (barriers). Thus further studies are needed to gain a better understanding of these variables. For example, the validation of a questionnaire that would help to define if after participating a in a lifestyle program promoting GI, the knowledge, attitudes and beliefs towards certain behaviours like consuming low-GI foods change. This would aid in the design of future interventions.

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Appendix A:

The Picking Up the Pace program workbook

Welcome to the Second Step Program

Did you know that by simply walking you can more easily manage your diabetes?

"No pain, No Gain" is No More!!!

You don't have to run a marathon to improve your health

The Second Step Program (SSP) will help you gradually increase your walking duration and intensity – without running!!!

The **Second Step Program** takes 12 weeks and is split into 3 Phases:

1) Getting Started Phase – 4 weeks
2) Feeling Fine Phase – 4 weeks
3) Feeling Great Phase – 4weeks

Q & A CENTRE

Q: What does walking duration mean?

A: the time you spend walking each day and each week.

Q: What does walking intensity mean?

A: the number of steps you take during a specific time.

FEELING FINE PHASE
GOAL PAGE

Remember:
At the beginning of each phase of the PUP Program you will be asked to meet a walking duration and a walking intensity goal.

DURATION GOAL – ***30 minutes*** intentional walking for ***4 days a week***

INTENSITY GOAL - you will be asked to set a goal for the number of steps you will take during **30 minutes of walking on 4 days.**

Please indicate your **intensity goal** for the **Feeling Fine Phase**

At the end of the **Feeling Fine Phase**:

Daily, I plan to take _____ steps in 30 minutes

Please answer the following questions related to your goals for the **Feeling Fine Phase**:

I am confident I will meet my daily 30 minute duration goal *during* the **Feeling Fine Phase** (circle one).

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

I am confident I will meet my daily intensity goal *during* the **Feeling Fine Phase** (circle one).

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

HOW DID YOU DO TODAY?

WEEK # 5 **DAY 1 of 4**

At the end of each of the days you walk please complete this brief diary.

1. Using **pedometer A**, please write down how many steps you took over the whole day: _____steps

2. How many minutes were you able to walk at your intensity goal today (please circle one)?

0 min 5 min 10 min 15 min 20 min 25 min 30 min

If you walked at your intensity goal for longer than 30 minutes, how long did you walk:_____

3. Using **pedometer B**, please write down the total number of steps you took during your timed walking: _____steps

4. When attempting to reach your duration goal, how did you do it?

3 x 10 minute bouts	2 x 15 minute bouts	1 x 30 minute bout
At what times during the day:	At what times during the day:	At what time during the day:
- please indicate the time (s) you walked today in the space provided		

4. Please circle the day you walked:

Sun. Mon. Tues. Wed. Thu. Fri. Sat.

5. How much did today's weather limit you from meeting your walking goals (please circle one):

Slightly	A little	Somewhat	Quite a lot	Completely
1	2	3	4	5

HOW DID YOU DO TODAY?

WEEK # 5 **DAY 1 of 4**

At the end of each day you walk please complete this brief diary.

7. Please circle the value below which bests describes how hard you felt you worked when completing your walking goal today:

6 7	very, very light
8 9	very light
10 11	fairly hard
12 13	somewhat hard
14 15	hard
16 17	very hard
18 19 20	very, very hard

8. When you completed your intentional walking today what was your heart rate:_____ bpm.

Questionnaire # 2

Section A

The following questions ask how confident you are about walking in the Second Step Program in different circumstances. Please circle only one response for each question.

Over the next 4 weeks I am confident that I can meet the goals of the Feeling Great Phase:

	Not at all Confident	Not Very Confident	Moderately Confident	Very Confident	Extremely Confident
1. when I am a bit tired.	1	2	3	4	5
2. when I am in a bad mood or feeling down.	1	2	3	4	5
3. when I have to do it by myself	1	2	3	4	5
4. when it becomes boring	1	2	3	4	5
5. when I can't notice any improvements in my health	1	2	3	4	5
6. when I have other demands for my time	1	2	3	4	5
7. when I feel stiff and sore	1	2	3	4	5
8. when the weather is bad	1	2	3	4	5

Section B

How much do you think the following ideas will influence your decision to meet the goals of the Feeling Great Phase where you will be asked to walk more intensely and on one more day a week?

	Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1. It will help me reduce tension or stress.	1	2	3	4	5
2. I will feel more confident about my health by getting more intense walking.	1	2	3	4	5
3. I will sleep better.	1	2	3	4	5
4. Will take too much of my time.	1	2	3	4	5
5. I will have less time for my family and friends if I participate in the Feeling Fine Phase.	1	2	3	4	5
6. I will get too tired to meet my Feeling Fine goals because of my other responsibilities.	1	2	3	4	5
7. The Feeling Fine goals will help me have a more positive outlook.	1	2	3	4	5
8. The Feeling Fine goals will help me control my weight.	1	2	3	4	5
9. I'd worry about looking awkward if others saw me being walking more intensely.	1	2	3	4	5

Section D

Consider the next 4 weeks of the Feeling Great Phase; circle the number that best describes how much you agree with the statement:

	Strongly agree	Moderately Agree	Slightly Disagree	Unsure	Slightly Agree	Moderately Agree	Strongly Agree
1. Most people in my social group want me to meet my walking goals.	1	2	3	4	5	6	7
2. Most people in my social group would approve if I walked regularly.	1	2	3	4	5	6	7
3. I will feel pressured from my social group to get meet my walking goals.	1	2	3	4	5	6	7
4. Most of my family members will participate when meeting my walking goals.	1	2	3	4	5	6	7
5. My doctor or health care provider thinks I should walk regularly.	1	2	3	4	5	6	7
6. My partner would participate in meeting my walking goals.	1	2	3	4	5	6	7

Section D (cont')

Consider the next 4 weeks of the Feeling Great Phase; circle the number that best describes how much you agree with the statement:

	Strongly agree	Moderately Agree	Slightly Disagree	Unsure	Slightly Agree	Moderately Agree	Strongly Agree
7. My co-workers will participate in helping me meeting my goals.	1	2	3	4	5	6	7
8. People in my social group are likely to help meeting my goals.	1	2	3	4	5	6	7
9. There is no one in my social group whom I can turn to for assistance with meeting my goals.	1	2	3	4	5	6	7
10. I feel that someone in my social group will provide the support I need to meet my goals.	1	2	3	4	5	6	7
11. Whether or not I meet my goals is mostly up to me.	1	2	3	4	5	6	7

Section D (cont')

12. How often during the Feeling Fine Phase:

	Never	Seldom	Occasionally	Often	Very Often
Did you ask someone to help you improve your walking goals?	1	2	3	4	5
Did you ask someone to walk with you?	1	2	3	4	5

Section E

How often did the following prevent you from meeting your Feeling Fine Phase goals?

	Never	Seldom	Occasionally	Often	Very Often
1. Lack of equipment	1	2	3	4	5
2. Lack of facilities or space	1	2	3	4	5
3. Lack of company to exercise with	1	2	3	4	5

4. How often do you see people walking or jogging in your neighborhood or area?

Never	Seldom	Occasionally	Often	Very Often
1	2	3	4	5

5. Are there any exercise facilities or programs where you work?

Yes	No	Not Sure	Not Applicable
1	2	3	4

6. Is it difficult to walk in your neighborhood? (because of traffic, lack of sidewalks, dogs etc.)

Yes □
No □

If you answered Yes above : When is the best time to walk in your neighborhood?

Morning □ Evening □
Afternoon □ Night □

FEELING GREAT PHASE
GOAL PAGE

Remember:
At the beginning of each phase of the PUP Program you will be asked to meet a walking duration and a walking intensity goal.

DURATION GOAL – ***30 minutes*** intentional walking for ***5 days a week***

INTENSITY GOAL - you will be asked to set a goal for the number of steps you will take during **30 minutes of walking on 5 days.**

Please indicate your **intensity goal** for the **Feeling Great Phase**

At the end of the **Feeling Great Phase:**

Daily, I plan to take _____ steps in 30 minutes

Please answer the following questions related to your goals for the **Feeling Great Phase**:

I am confident I will meet my daily 30 minute duration goal *during* the **Feeling Great Phase** (circle one).

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

I am confident I will meet my daily intensity goal *during* the **Feeling Great Phase** (circle one).

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

HOW DID YOU DO TODAY?

WEEK # 9 **DAY 1 of 5**

At the end of each of the days you walk please complete this brief diary.

1. Using **pedometer A**, please write down how many steps you took over the whole day: _____steps

2. How many minutes were you able to walk at your intensity goal today (please circle one)?

0 min **5 min** **10 min** **15 min** **20 min** **25 min** **30 min**

If you walked at your intensity goal for longer than 30 minutes, how long did you walk:_____

3. Using **pedometer B**, please write down the total number of steps you took during your timed walking: _____steps

4. When attempting to reach your duration goal, how did you do it?

3 x 10 minute bouts	2 x 15 minute bouts	1 x 30 minute bout
At what times during the day:	At what times during the day:	At what time during the day:
- please indicate the time (s) you walked today in the space provided		

4. Please circle the day you walked:

Sun. **Mon.** **Tues.** **Wed.** **Thu.** **Fri.** **Sat.**

5. How much did today's weather limit you from meeting your walking goals (please circle one):

Slightly	A little	Somewhat	Quite a lot	Completely
1	2	3	4	5

HOW DID YOU DO TODAY?

WEEK # 9 **DAY 1 of 5**

At the end of each day you walk please complete this brief diary.

7. Please circle the value below which bests describes how hard you felt you worked when completing your walking goal today:

6 7	very, very light
8 9	very light
10 11	fairly hard
12 13	somewhat hard
14 15	hard
16 17	very hard
18 19 20	very, very hard

8. When you completed your intentional walking today what was your heart rate:_____ bpm.

Questionnaire # 2

Section A

The following questions ask how confident you are about walking in the Second Step Program in different circumstances. Please circle only one response for each question.

Over the next 4 weeks I am confident that I can meet the goals of the Feeling Great Phase:

	Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1. when I am a bit tired.	1	2	3	4	5
2. when I am in a bad mood or feeling down.	1	2	3	4	5
3. when I have to do it by myself	1	2	3	4	5
4. when it becomes boring	1	2	3	4	5
5. when I can't notice any improvements in my health	1	2	3	4	5
6. when I have other demands for my time	1	2	3	4	5
7. when I feel stiff and sore	1	2	3	4	5
8. when the weather is bad	1	2	3	4	5

Section B

How much do you think the following ideas will influence your decision to meet the goals of the Feeling Great Phase where you will be asked to walk more intensely and on one more day a week?

	Not at all Confident	Not very Confident	Moderately Confident	Very Confident	Extremely Confident
1. It will help me reduce tension or stress.	1	2	3	4	5
2. I will feel more confident about my health by getting more intense walking.	1	2	3	4	5
3. I will sleep better.	1	2	3	4	5
4. Will take too much of my time.	1	2	3	4	5
5. I will have less time for my family and friends if I participate in the Feeling Fine Phase.	1	2	3	4	5
6. I will get too tired to meet my Feeling Fine goals because of my other responsibilities.	1	2	3	4	5
7. The Feeling Fine goals will help me have a more positive outlook.	1	2	3	4	5
8. The Feeling Fine goals will help me control my weight.	1	2	3	4	5
9. I'd worry about looking awkward if others saw me being walking more intensely.	1	2	3	4	5

Section D

Consider the next 4 weeks of the Feeling Great Phase; circle the number that best describes how much you agree with the statement:

	Strongly agree	Moderately Agree	Slightly Disagree	Unsure	Slightly Agree	Moderatel y Agree	Strongly Agree
1. Most people in my social group want me to meet my walking goals.	1	2	3	4	5	6	7
2. Most people in my social group would approve if I walked regularly.	1	2	3	4	5	6	7
3. I will feel pressured from my social group to get meet my walking goals.	1	2	3	4	5	6	7
4. Most of my family members will participate when meeting my walking goals.	1	2	3	4	5	6	7
5. My doctor or health care provider thinks I should walk regularly.	1	2	3	4	5	6	7
6. My partner would participate in meeting my walking goals.	1	2	3	4	5	6	7

Section D (cont')

Consider the next 4 weeks of the Feeling Great Phase; circle the number that best describes how much you agree with the statement:

	Strongly agree	Moderately Agree	Slightly Disagree	Unsure	Slightly Agree	Moderately Agree	Strongly Agree
7. My co-workers will participate in helping me meeting my goals.	1	2	3	4	5	6	7
8. People in my social group are likely to help meeting my goals.	1	2	3	4	5	6	7
9. There is no one in my social group whom I can turn to for assistance with meeting my goals.	1	2	3	4	5	6	7
10. I feel that someone in my social group will provide the support I need to meet my goals.	1	2	3	4	5	6	7
11. Whether or not I meet my goals is mostly up to me.	1	2	3	4	5	6	7

Section D (cont')

12. How often during the Feeling Fine Phase:

	Never	Seldom	Occasionally	Often	Very Often
Did you ask someone to help you improve your walking goals?	1	2	3	4	5
Did you ask someone to walk with you?	1	2	3	4	5

Section E

How often did the following prevent you from meeting your Feeling Fine Phase goals?

	Never	Seldom	Occasionally	Often	Very Often
1. Lack of equipment	1	2	3	4	5
2. Lack of facilities or space	1	2	3	4	5
3. Lack of company to exercise with	1	2	3	4	5

4. How often do you see people walking or jogging in your neighborhood or area?

Never	Seldom	Occasionally	Often	Very Often
1	2	3	4	5

5. Are there any exercise facilities or programs where you work?

Yes	No	Not Sure	Not Applicable
1	2	3	4

6. Is it difficult to walk in your neighborhood? (because of traffic, lack of sidewalks, dogs etc.)

Yes □
No □

If you answered Yes above : When is the best time to walk in your neighborhood?

Morning □ Evening □
Afternoon □ Night □

Appendix B:

Abstracts and additional data collected from pilot study (Chapter 3)

Pedometer Based Approach to Brisk Walking: A Feasibility Assessment of The First Step Program – Picking Up the Pace. STEVEN T. JOHNSON[1*], EDMOND RYAN[2], RONALD PLOTNIKOFF, VICKI HARBER[3], GORDON BELL[3], LINDA J. MCCARGAR[1], CATRINE TUDOR-LOCKE[4], RHONDA C. BELL[1]. [1]Agricultural, Food and Nutritional Science; [2]Dpt. of Medicine; [3]Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB; [4]Dpt. of Exercise and Wellness, Arizona State University East, Mesa, AZ

The objective of this study was to test the feasibility of increasing walking pace (and therefore intensity), weekly frequency and duration to meet current guidelines for the management of type 2 diabetes (T2D) which suggest moderately intense physical activity on most days of the week within a 3-phase, 12-week pedometer based lifestyle program. Baseline self-selected walking intensity was determined during a 10-minute track test where participants with T2D (n=10, 7men:3women, mean ± SEM 53.9±2.4 years of age and BMI 32.1±1.2) wore a pedometer, an Activity Monitoring Pod and a heart rate monitor to measure steps/10min, walking speed (m/s) and heart rate (bpm) response respectively: from this, individual walking intensity goals were set only as a 10% increase in steps/30 min/phase. In addition, frequency goals incrementally increased from 3 to 5 times each week over the three phases. During the program, subjects recorded their total daily steps; final heart rate, rating of perceived exertion and total steps following each 30 min brisk walking bout. The analyses focused on compliance to this regime in addition to anthropometric and biochemical measures. During phase 1, 2 and 3: 70%, 20% and 1% of participants met program frequency and duration goals while walking at a mean ± SEM age predicted % of heart rate maximum of 74.0±2.0, 77.2±2.0 and 76.7±2.8 respectively. A significant ($P<0.05$) reduction in weight (90.9 ± 4.8 vs. 89.0 ± 4.7 kg) and resting heart rate (73.6 ± 3.0 vs. 68.3 ± 3.5 bpm) were detected after 12-weeks. Program participants exceeded the intensity recommendations for 'moderately intense' exercise as measured by heart rate response. Compliance to frequencies more than 3 days/week dramatically dropped-off. The progression to a faster walking pace (steps/30 min) within a single 4-week phase is feasible (based on the rate of compliance) for individuals with T2D within a pedometer-based walking program on 3 days/week, but fully complying with current clinical practice guidelines for PA frequency at this intensity within 12-weeks may not be feasible.

Results Summary:

The following paragraph provides a summary of unpublished data collected for the pilot study described in Chapter 3. Following the 12 week walking program (Table 1), a significant reduction in body weight (Δ = -1.8 ± 1.6 kg, $p < 0.02$), BMI (Δ = -0.6 ± 0.6 kg/m^2, $p < 0.01$) and waist/hip ratio (-0.2 ± 0.02 cm, $p < 0.01$) were observed. After the 12 week program, hip circumference increased by 2.2 ± 0.9 cm ($p < 0.01$). Dual energy X-ray absorptiometry (DEXA) revealed no changes in fat or fat free mass. A significant reduction in resting heart rate (Δ = -6.9 ± 6.4 beats per minute, $p = 0.02$) was measured, however, no changes were detected for systolic or diastolic blood pressure after the 12 week study. Among the measurements of glycemia, a significant reduction in fasting insulin (Δ = -4.5 ± 3.6 mU/l, $p = 0.009$) was found; however, no changes in fasting glucose or A_{1c} were found after 12 weeks. No measurable changes were detected for any of the serum lipids measured.

Table 1. Effects of a 12-week pedometer based walking intensity program on the anthropometric and metabolic profile of 8 type 2 diabetic subjects

	Basal	Post	Δ	95% CI of Δ	P
Anthropometry					
Weight (kg)	88.8 ± 15.2	87.0 ± 15.1	-1.8 ± 1.6	-0.4 to -3.2	0.02*
BMI (kg/m^2)	31.5 ± 4.0	30.8 ± 3.9	-0.6 ± 0.6	-0.2 to -1.1	0.01*
Waist circumference (cm)	104.8 ± 11.5	104.7 ± 11.0	-0.2 ± 1.5	-1.4 to 1.1	0.78
Hip circumference (cm)	104.9 ± 9.5	107.1 ± 9.8	2.2 ± 0.9	1.5 to 3.0	0.00*
Waist/Hip ratio	1.0 ± 0.1	0.98 ± 0.1	-0.2 ± 0.02	-0.01 to -0.04	0.01*
Body Composition by DEXA					
Fat mass[¶] (%)	36.2 ± 9.0	36.1 ± 8.9	-0.1 ± 1.3	1.1 to -1.32	0.82
Fat free Mass (%)	63.8 ± 9.0	63.6 ± 8.7	-0.13 ± 1.1	0.9 to -1.2	0.78
Resting Blood Pressure					
Systolic (mmHg)	121.5 ± 7.8	118.9 ± 12.4	-2.6 ± 10.2	5.9 to -11.1	0.49
Diastolic (mmHg)	81.6 ± 7.3	80.1 ± 8.3	1.1 ± 2.7	1.2 to -3.3	0.31
Resting heart rate (bpm)	71.5 ± 8.7	64.6 ± 8.8	6.9 ± 6.4	-1.6 to -12.2	0.02*
Glycemic Indices					
Fasting glucose (mmol/l)	8.9 ± 2.4	7.9 ± 2.3	-1.0 ± 1.4	0.2 to -2.1	0.08
Fasting insulin (mU/l)	14.3 ± 9.0	9.8 ± 5.9	-4.5 ± 3.6	-1.6 to -7.5	0.009*
HbA1c (%)	6.93 ± 1.2	6.58 ± 1.1	-0.35 ± 0.6	0.11 to -0.81	0.11
Serum Lipids					
Total cholesterol (mmol/l)	4.7 ± 0.9	4.8 ± 0.6	0.1 ± 0.6	0.6 to -0.4	0.58
HDL (mmol/l)	1.1 ± 0.2	1.1 ± 0.2	0.05 ± 0.1	0.1 to -0.04	0.23
LDL (mmol/l)[§]	2.9 ± 0.8	2.9 ± 0.6	0.01 ± 0.5	0.4 to -0.4	0.97
Triglycerides (mmol/l)	1.6 ± 0.6	1.7 ± 0.6	0.1 ± 0.6	0.6 to -0.3	0.52
TC/TG	4.4 ± 0.7	4.3± 0.7	-0.03 ± 0.7	0.5 to -0.6	0.92

Data reported as mean ± SD;[¶] n=6; *P<0.05 vs. basal

Table 2. Time spent and total steps with indicators of intensity during brisk walking in a 12-week pedometer based walking program

	Phase 1 (*n=10*)	Phase 2 (*n=9*)	Phase 3 (*n=8*)
Feasibility assessment of physical activity			
Mean walking frequency (days/phase)	11.7 ± 0.7	13.7 ± 3.6	13.5 ± 6.4
Percentage of goal days	98	85	68
Mean duration (mins/phase)	341.0 ± 40.1	393.3 ± 125.0	398.8 ± 189.0
Percentage of goal time	95	82	67
Average number of PUP days/week	2.9 ± 0.2	3.4 ± 0.9	3.4 ± 1.6
Percentage of goal days/week	97	85	68
PUP days*			
Intentional brisk pace (steps/30 min)	4073 ± 398	4084 ± 413	4142 ± 340
Total daily (steps/24 hours)	12370 ± 3361	13099 ± 5568	13932 ± 5883
Total daily – brisk pace (steps/24 hours)	8297 ± 3165	9014 ± 5330	9790 ± 5744
Contribution of PUP steps to total daily steps (%)	33	31	30
Intensity			
Final heart rate (bpm)	125 ± 8.3	130 ± 12	127 ± 8
Age predicted heart $rate_{max}$ (%)	75.1 ± 5.4	77.9 ± 6.4	76.7 ± 7.8
Perceived Exertion (Borg)	13.8 ± 3.3	14.6 ± 4.1	14.5 ± 4.3

- data presented as mean ± SD unless otherwise stated; *subject reported pedometer values for steps.

Table 3. Effects of a 12-week pedometer based walking program on cardiorespiratory measures during a graded submaximal treadmill test

	Treadmill Stage							
	Pre				Post			
	1	2	3	4	1	2	3	4
Systolic BP (mmHg)	152.0±16.0	167.6±14.7	178.0±4.6	195.2±11.1	140.6±13.2	150.1±15.8*	163.6±13.9	181.2±11.8*
Diastolic BP (mmHg)	86.9±8.1	86.6±4.0	84.1±7.8	82.3±4.6	83.1±4.1	82.0±4.2*	80.7±3.6	79.4±1.6
Heart Rate (BPM)	99±2.9	108.4±3.3	117.1±3.0	134.0±2.8	91.4±3.6*	97.8±3.8*	109.7±3.9*	127.1±2.8*
N	7	7	7	6	7	7	7	7

Data presented as mean ± SD; * significant difference from baseline RM-ANOVA ($P<0.05$)

Table 4. Mean cardiorespiratory responses and ambulatory characteristics during a 10 minute track test following a 12-week pedometer based walking program

Variable	Pre	Post	P
Steps	1244 ± 133	1207 ± 120	0.4
Speed (km/h)	4.8 ± 0.6	4.9 ± 0.4	0.7
Final heart rate (bpm)	113 ± 10	101 ± 12	0.03*
Age predicted heart $rate_{max}$ (%)	69.1 ± 8.0	63.6 ± 7.4	0.02*
Rating of perceived exertion	8.9 ± 0.9	9.0 ± 1.0	0.80
N	7	7	

Data presented as means ± SD; *P<0.05 by RM-ANOVA

Table 5. Mean ambulatory characteristics during a 10 minute track test before a 12–week pedometer based walking program.

	Baseline	
Variable	**Pedometer (n=11)**	**AMP 331(n=10)**
Steps/10min	1210 ± 48	1182 ± 20
Steps/min	121 ± 5	118 ± 2
Speed[§] [m/s]	1.49 ± 0.05	1.30 ± 0.05
Speed[†] [km/h]	5.36 ± 0.18	4.69 ± 0.18

Data are presented as means ± SEM; [§] Speed for pedometer category calculated from average time to complete a lap of a 200 metre track (n = 4 laps) where speed = 200metres/average time to complete 4 laps (seconds); [†]conversion from m/s calculated with http://www.onlineconversion.com/speed.htm.

Changes in Psychosocial Construct Scores Over Time in a Walking Program Implementing Progressive Frequency and Intensity in Type 2 Diabetes.

STEVEN T. JOHNSON[1], RONALD PLOTNIKOFF[2], VICKI HARBER[2], GORDON BELL[2], LINDA J. MCCARGAR[1], CATRINE TUDOR-LOCKE[3], RHONDA C. BELL[1].
[1]Dept. of AFNS, [2]Faculty of Phys. Ed. Rec., University of Alberta, Edmonton, AB; [3]Dept of Ex. Wellness, Arizona State University, East Mesa, AZ.

This pilot study measured self efficacy, decisional balance (pros and cons) and social support associated with increasing walking intensity and frequency goals in people with type 2 diabetes (n=6; 4M,2F, age= 53.2 ± 8.2 years) within a 3-phase, 12-week pedometer based walking program. Self-selected walking intensity was determined at baseline by measuring steps/10min using a pedometer: from this, individual walking intensity goals were set as a 10% increase in steps/30 min/phase. Phase frequency goals were pre-set at 3, 4, and 5 days/week. At the beginning of each phase, participants' psychosocial construct scores were assessed using validated measures; change within subjects over time was determined using repeated measures ANOVA. Decreasing self efficacy ($p<0.01$) and perceived social support ($p<0.05$) were found as intensity and frequency goals increased. The proportion of participants who attained program goals and returned completed the psychosocial assessment in phases 1, 2 and 3 were: intensity: 50%, 0% and 0%, and frequency 88%, 25%, 13% respectively. Self-efficacy and perceived social support are important mediators of goal achievement with respect to walking intensity and frequency. This pilot work points to the need for further longitudinal studies to document changes in psychosocial constructs relative to lifestyle modification goals.

Section A - Confidence/Self efficacy

Over the next 4 weeks I am confident that I can meet the goals for this phase:

Q-1 When I am a bit tired.

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	66.7	12.5
Not very Confident	25	25	0	25
Moderately Confident	37.5	50	33.3	37.5
Very Confident	25	12.5	0	25
Extremely Confident	12.5	0	0	0
N	**8**	**8**	**6**	**8**

Q-2 When I an a bad mood or feeling down

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	12.5
Not very Confident	25	0	0	0
Moderately Confident	37.5	50	50	25
Very Confident	25	25	0	62.5
Extremely Confident	12.5	12.5	0	0
N	**8**	**8**	**6**	**8**

Q-3 When I have to do it by myself

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	12.5
Not very Confident	0	0	0	0
Moderately Confident	37.5	50	16.7	25
Very Confident	37.5	12.5	33.3	37.5
Extremely Confident	25	25	0	25
N	**8**	**8**	**6**	**8**

Q-4 When it becomes boring

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	12.5
Not very Confident	0	0	0	0
Moderately Confident	37.5	50	50	37.5
Very Confident	50	12.5	0	37.5
Extremely Confident	12.5	25	0	12.5
N	**8**	**8**	**6**	**8**

Q-5 When I can't notice any improvements in my health

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	12.5
Not very Confident	25	12.5	0	0
Moderately Confident	12.5	37.5	50	37.5
Very Confident	50	25	0	50
Extremely Confident	12.5	12.5	0	0
N	**8**	**8**	**6**	**8**

Q-6 When I have other demands for my time

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	25	50	25
Not very Confident	37.5	12.5	33.3	37.5
Moderately Confident	25	62.5	16.7	25
Very Confident	37.5	0	0	12.5
Extremely Confident	0	0	0	0
N	**8**	**8**	**6**	**8**

Q-7 When I feel stiff and sore

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	25
Not very Confident	12.5	12.5	0	0
Moderately Confident	25	62.5	50	37.5
Very Confident	62.5	0	0	25
Extremely Confident	0	12.5	0	12.5
N	**8**	**8**	**6**	**8**

Q-8 When the weather is bad

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	12.5	50	25
Not very Confident	50	37.5	16.7	12.5
Moderately Confident	12.5	37.5	33.3	50
Very Confident	25	0	0	12.5
Extremely Confident	12.5	12.5	0	0
N	**8**	**8**	**6**	**8**

Section B. Pros/Cons

How much do you think the following ideas will influence your decision to meet the goals for this phase where you will asked to walk more intensely and more frequently?

Q – 1 It will help me reduce tension or stress

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	0	0	0
Not very Confident	0	12.5	0	0
Moderately Confident	12.5	50	50	25
Very Confident	87.5	12.5	33.3	25
Extremely Confident	0	25	16. 7	50
N	**8**	**8**	**6**	**8**

Q – 2 It will feel more confident about my health by getting more intense walking.

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	0	0	12.5
Not very Confident	0	12.5	0	0
Moderately Confident	37.5	25	50	50
Very Confident	37.5	37.5	50	0
Extremely Confident	**25**	**25**	**0**	**37.5**
N	**8**	**8**	**6**	**8**

Q – 3 I will sleep better

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	0	0	12.5
Not very Confident	0	0	0	12.5
Moderately Confident	50	50	66. 7	25
Very Confident	25	37.5	33. 3	25
Extremely Confident	25	12.5	0	25
N	**8**	**8**	**6**	**8**

Q – 4 It will take too much of my time

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	14.3	37.5	60	37.5
Not very Confident	42.8	12.5	0	50
Moderately Confident	28.6	50	40	0
Very Confident	14.3	0	0	12.5
Extremely Confident	0	0	0	0
N	**7**	**8**	**6**	**8**

Q – 5 I will have less time for my family and friends if I participate in this phase

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	37.5	37.5	50	50
Not very Confident	12.5	12.5	16. 7	12.5
Moderately Confident	37.5	37.5	33. 3	37.5
Very Confident	12.5	12.5	0	0
Extremely Confident	0	0	0	0
N	**8**	**8**	**6**	**8**

Q – 6 I will get to tired to meet the phase goals because of my other responsibilities

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	25	25	40	37.5
Not very Confident	25	37.5	0	25
Moderately Confident	37.5	37.5	60	37.5
Very Confident	12.5	0	0	0
Extremely Confident	0	0	0	0
N	**8**	**8**	**5**	**8**

Q – 7 The phase goals will help me have a more positive outlook

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	0	0	0
Not very Confident	0	12.5	20	0
Moderately Confident	25	12.5	60	37.5
Very Confident	50	37.5	20	12.5
Extremely Confident	25	37.5	0	50
N	8	8	5	

Q – 8 The phase goals will help me control my weight

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	0	0	0	0
Not very Confident	0	25	20	0
Moderately Confident	25	12.5	60	25
Very Confident	50	25	20	37.5
Extremely Confident	25	37.5	0	37.5
N	**8**	**8**	**5**	**8**

Q – 9 I'd worry about looking awkward if others saw me walking more intensely

	Week 1	Week 4	Week 8	Week 12
Not at all Confident	37.5	50	60	75
Not very Confident	12.5	0	40	12.5
Moderately Confident	37.5	12.5	0	0
Very Confident	0	12.5	0	0
Extremely Confident	12.5	25	0	12.5
N	**8**	**8**	**5**	**8**

Section C Social Support

Consider the next 4 weeks of this phase; which statement best describes how much you agree with the statement:

Q – 1 Most people in my social group want me to meet my walking goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	0	0	0	0
Moderately disagree	0	0	0	0
Slightly disagree	0	0	0	0
Unsure	12.5	0	0	0
Slightly Agree	12.5	12.5	33.3	33.3
Moderately Agree	37.5	37.5	33.3	33.3
Strongly Agree	37.5	50	33. 3	33.3
N	**8**	**8**	**6**	**8**

Q – 2 Most people in my social group would approve if I walked regularly

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	12.5	0	16. 7	0
Moderately disagree	0	0	0	0
Slightly disagree	0	0	0	0
Unsure	0	12.5	0	0
Slightly Agree	12.5	12.5	33.3	37.5
Moderately Agree	50	50	33.3	25
Strongly Agree	25	25	16.7	37.5
N	**8**	**8**	**6**	**8**

Q – 3 I will feel pressured from my social group to meet my walking goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	12.5	37.5	33.3	25
Moderately disagree	0	12.5	0	0
Slightly disagree	12.5	0	16.7	12.5
Unsure	12.5	0	0	12.5
Slightly Agree	37.5	12.5	50	37.5
Moderately Agree	12.5	37.5	0	12.5
Strongly Agree	12.5	0	0	0
N	**8**	**8**	**6**	**8**

Q – 4 Most of my family members will participate when meeting my walking goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	25	25	33. 3	50
Moderately disagree	0	0	16. 7	0
Slightly disagree	25	37.5	33. 3	12.5
Unsure	0	12.5	0	12.5
Slightly Agree	12.5	12.5	0	12.5
Moderately Agree	25	0	0	12.5
Strongly Agree	12.5	12.5	16.7	0
N	**8**	**8**	**6**	**8**

Q – 5 My doctor or health care provider thinks I should walk regularly

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	0	0	0	12.5
Moderately disagree	0	0	0	0
Slightly disagree	0	0	0	0
Unsure	12.5	0	16.7	0
Slightly Agree	0	37.5	33.3	37.5
Moderately Agree	37.5	25	16.7	0
Strongly Agree	50	37.5	33.3	50
N	**8**	**8**	**6**	**8**

Q – 6 My partner would participate in meeting my walking goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	12.5	37.5	16.7	25
Moderately disagree	0	0	16.7	0
Slightly disagree	12.5	12.5	33.3	25
Unsure	0	12.5	0	25
Slightly Agree	25	12.5	16.7	12.5
Moderately Agree	12.5	12.5	0	12.5
Strongly Agree	37.5	12.5	16.7	0
N	**8**	**8**	**6**	**8**

Q – 7 My co-workers will participate in helping me meeting my goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	28.6	28.6	66.7	62.5
Moderately disagree	0	0	0	0
Slightly disagree	0	0	0	0
Unsure	14.3	14.3	0	12.5
Slightly Agree	14.3	14.3	33.3	25
Moderately Agree	28.6	28.6	0	0
Strongly Agree	14.3	14.3	0	0
N	**7**	**8**	**6**	**8**

Q – 8 People in my social group are likely to help meeting my goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	12.5	25	50	25
Moderately disagree	0	25	0	25
Slightly disagree	0	12.5	0	0
Unsure	12.5	0	33.3	50
Slightly Agree	25	25	16.7	0
Moderately Agree	25	12.5	0	0
Strongly Agree	25	0	0	0
N	**8**	**8**	**6**	**8**

Q – 9 There is no one in my social group whom I can turn to for assistance with meeting my goals.

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	25	12.5	33.3	12.5
Moderately disagree	50	12.5	0	0
Slightly disagree	0	25	16.7	0
Unsure	12.5	12.5	0	25
Slightly Agree	12.5	25	33.3	25
Moderately Agree	0	0	16.7	37.5
Strongly Agree	0	12.5	0	0
N	**8**	**8**	**6**	**8**

Q – 10 I feel that someone in my social group will provide the support I need to meet my goals

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	12.5	12.5	33.3	12.5
Moderately disagree	0	12.5	0	12.5
Slightly disagree	0	0	0	12.5
Unsure	12.5	12.5	16.7	12.5
Slightly Agree	12.5	37.5	33.3	37.5
Moderately Agree	37.5	12.5	16.7	0
Strongly Agree	25	12.5	0	12.5
N	**8**	**8**	**6**	**8**

Q – 11 Whether I meet my goals is mostly up to me

	Week 1	Week 4	Week 8	Week 12
Strongly disagree	0	0	16.7	0
Moderately disagree	0	0	0	0
Slightly disagree	0	0	0	0
Unsure	0	0	16.7	0
Slightly Agree	0	0	0	0
Moderately Agree	0	37.5	0	0
Strongly Agree	100	62.5	66.7	100
N	**8**	**8**	**6**	**8**

Q -12 How often during this phase:

(a) did you ask someone to help you improve your walking goals

	Week 1	Week 4	Week 8	Week 12
Never	37.5	37.5	20	25
Seldom	25	37.5	20	37.5
Occasionally	12.5	12.5	20	25
Often	50	12.5	40	0
Very often	0	0	0	12.5
N	**8**	**8**	**5**	**8**

(b) Did you ask someone to walk with you

	Week 1	Week 4	Week 8	Week 12
Never	37.5	37.5	16.7	25
Seldom	25	25	0	0
Occasionally	25	25	33.3	50
Often	12.5	12.5	50	12.5
Very often	37.5	37.5	16.7	12.5
N	**8**	**8**	**6**	**8**

Appendix C:

Phase I resource manual and log book

STEPPING FORWARD

Physical Activity is important for the management of diabetes. It will help to control your blood sugar, improve your fitness and help to reduce or maintain your weight.

Being physically active is often hard to do for many reasons. Taking part in this program will help you to get started and you will be taking an important ***STEP FORWARD***.

This program will help you to become more active on a daily basis.

THINK ABOUT THIS:

Change is good but not always easy. Let's think about how you might benefit from being more active and what changes you might need to make in your daily life.

PROS for me (what are the positives for being more active?)

Plans to be more active (what are some obstacles you might encounter?)

WHAT IS ACTIVE LIVING ANYWAY?

Generally, active living is repeated bodily movement done to improve one's level of physical fitness.

Physical fitness is person's *ability* to be physically active and is related to strength and flexibility but also to how well your heart and lungs work when you are active.

It is important to remember that your health is a resource and not simply not being unhealthy. When we are healthy we are capable of living up to our potential. Being physically active will improve or maintain your health and help you achieve your potential.

HOW MUCH ACTIVITY DO I NEED EACH DAY?

For managing diabetes, most experts would suggest 30 minutes/day.

Walking is the simplest form of activity and can fit into most people's day.

The more active you become the greater the benefit for your health.

WHAT IS HEALTHY EATING AND ACTIVE LIVING FOR DIABETES ALL ABOUT?

This is a study to help people with type 2 diabetes learn to manage their disease with both diet and physical activity.

Over the next 6 months you will learn how to use a pedometer to keep track of your daily activity. Your will learn how many steps you take each day . You will learn how to increase the number of steps you take each day. You will learn about how certain foods can help to manage your diabetes.

During the first 3 months there will be 4 weekly group meetings. You will learn how to set goals for steps/day. After the first 3 months, you will continue to learn how to use a pedometer along with nutritional strategies for your diabetes management.

You will be with other people like you, attempting to live an active lifestyle. You are encouraged to bring a friend, co-worker, spouse or relative to help you. We will work to help you plan to live a more active lifestyle. Try to come to all the meetings.

During the first 3 months, you will have a small weekly homework assignment. You will set a daily active living goal using your pedometer (steps/day).

Over the course of each day, open up your pedometer and see how close you are to your goals. When your day is done, write the steps/day in your activity calendar. If you meet your goal.....**WAY TO GO...**check off the box drawn on that day.

IS THERE A RIGHT OR WRONG AMOUNT OF STEPS I SHOULD TAKE?

Good question. The answer will be different for everyone. The best thing to do is to find out how many steps you take on a normal day.

I take _____ steps/day.

WHERE DO YOU FIT IN?

Children (8-10 years old)	12,000 – 16,000
Healthy younger adults (20-50 years old)	7,000 – 13,000
Healthy older adults (> 50 years old)	6,000 – 8,500
Individuals with disabilities or chronic illness	Less than 5,500

- adapted from Tudor-Locke (2001)

These are not necessarily ideal targets for you. They are really just an estimate of what people actually do. BUT, the more steps you take each day the better.

SO, HOW CAN I INCREASE MY STEPS/DAY?

What part of your day do you think you can fit in more steps?

_____

_____

_____

What do you do now that will give you less steps/day?

_____

_____

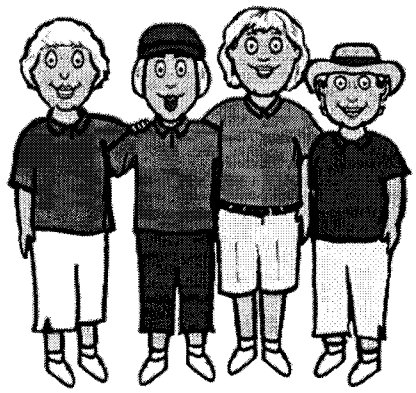
_____

Who can help you to increase your steps/day? How could they help you?

_____

_____

_____



SETTING GOALS - WEEK 1

Date:_____

This week I took _____steps in _____ minutes.

My average daily steps/day for last week was_____steps/day

I will increase this by + _____steps/day

My new daily goal is + _____steps/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

How confident are you that you can stick to your daily walking 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 walking goal?

0 1 2 3 4 5 6 7

WEEK 2

HOW DID YOU DO?

How many total steps did you take during the week?_____

How many days were you able to meet your goal?_____

My average steps/day = # of days divided by the number of steps on these days_____

WHAT WORKED?

On the days you got the most steps/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

On the days when you had low steps/day, what did you do?

_____

_____

_____

Did the pedometer help you walk more?

Y N

WEEK 2

THIS WEEK'S CO-WALKERS

Did you tell anyone you were in a walking program?

Y N

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

Y N

How can your friends, co-workers or family help you to walk more?

LET'S GO FOR A WALK!

This week we will go for a 20 minute walk.

Note how many steps are on your pedometer before you start.

When you are done the walk, check your pedometer – how many steps did you take in the 20 minutes?

You will need to subtract the steps you took from the steps at the start.

SETTING GOALS - WEEK 2

Date:_____

This week I took _____steps in _____ minutes.

My average daily steps/day for last week was_____steps/day

I will increase this by + _____steps/day

My new daily goal is + _____steps/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

How confident are you that you can stick to your daily walking 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 walking goal?

0 1 2 3 4 5 6 7

WEEK 2

HOW DID YOU DO?

How many total steps did you take during the week?_____

How many days were you able to meet your goal?_____

My average steps/day = # of days I met my goal divided by the number of steps on these days_____

WHAT WORKED?

On the days you got the most steps/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

On the days when you had low steps/day, what did you do?

_____

_____

_____

Did the pedometer help you walk more?

Y N

WEEK 2

THIS WEEK'S CO-WALKERS

Did you tell anyone you were in a walking program?

Y N

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

Y N

How can your friends, co-workers or family help you to walk more?

LET'S GO FOR A WALK!

This week we will go for a 30 minute walk.

Note how many steps are on your pedometer before you start.

When you are done the walk, check your pedometer – how many steps did you take in the 30 minutes?

You will need to subtract the steps you took over 30 minutes from the steps on your pedometer at the start.

SETTING GOALS - WEEK 3

Date:_____

This week I took _____steps in _____ minutes.

My average daily steps/day for last week was_____steps/day

I will increase this by + _____steps/day

My new daily goal is + _____steps/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

How confident are you that you can stick to your daily walking 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 walking goal?

0 1 2 3 4 5 6 7

WEEK 3

HOW DID YOU DO?

How many total steps did you take during the week?_____

How many days were you able to meet your goal?_____

My average steps/day = # of days I met my goal divided by the number of steps on these days_____

WHAT WORKED?

On the days you got the most steps/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

On the days when you had low steps/day, what did you do?

_____

_____

_____

Did the pedometer help you walk more?

Y N

WEEK 3

THIS WEEK'S CO-WALKERS

Did you tell anyone you were in a walking program?

Y N

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

Y N

How can your friends, co-workers or family help you to walk more?

LET'S GO FOR A WALK!

This week we will go for a 30 minute walk.

Note how many steps are on your pedometer before you start.

When you are done the walk, check your pedometer – how many steps did you take in the 30 minutes?

You will need to subtract the steps you took over 30 minutes from the steps on your pedometer at the start.

SETTING GOALS - WEEK 4

Date:_____

This week I took _____steps in _____ minutes.

My average daily steps/day for last week was_____steps/day

I will increase this by + _____steps/day

My new daily goal is + _____steps/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

How confident are you that you can stick to your daily walking 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 walking goal?

0 1 2 3 4 5 6 7

WEEK 4

I might take a step backward

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

How would you feel if you didn't reach you steps/day goal?

_____

_____

_____

PLANNING TO STAY STEP FORWARD

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

Have you ever had trouble staying physically active? If you answered yes, list some of the reasons why

_____

_____

_____

If you had trouble staying active, what helped you get back on track?

_____

_____

_____

WEEK 4

PLANNING TO STAY STEPPING FORWARD

If you find you are having trouble stepping forward:

What will help you to start walking more again?

_____

_____

_____

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 get your goal steps in	Plans to overcome the trouble spots and maintain your goals

RECORDING YOUR STEPS

Daily:

- At the start of each week write in your goal steps/day
- Each night, write down the number of steps you took during the day
- If you meet the goal, check the box at the top corner

Weekly:

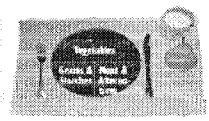
- Count the number of check marks for the week
- Add-up all the steps you took during the week
- Divide the total steps by the number of days you wore the pedometer to get your new average steps/day

STEP GOAL	Sun	Mon	Tue	Wed	Thu	Fri	Sat	How I did

Appendix D:

"The Glycemic Index Explained" (CDA, 2003) Presentation and handout used in the Basic and Enhanced lifestyle programs

THE GLYCEMIC INDEX



What is the Glycemic Index of food?

The Glycemic Index (GI) is a scale that ranks carbohydrate-rich foods by **how much** they raise blood glucose levels compared to a standard food. The standard food is glucose or white bread.

Why should I eat foods with a low Glycemic Index?

Eating foods with a low Glycemic Index may help you to:

- Control your blood glucose level
- Control your cholesterol level
- Control your appetite
- Lower your risk of getting heart disease
- Lower your risk of getting type 2 diabetes

Use these meal planning ideas to include the Glycemic Index as part of healthy eating.

- Enjoy vegetables, fruits and low-fat milk products with your meals. These are carbohydrate-rich foods that, in general, have low glycemic index.
- Plan your meals with foods in the low and medium Glycemic Index starch choices on the list that follows.
- Try foods such as barley, bulgar, couscous, or lentils, which have a low Glycemic Index.
- Consult a registered dietitian for help with choosing low GI foods, adapting recipes, and other ways to incorporate low GI foods in your meal plan.

If I eat foods with a low Glycemic Index can I eat as much as I want?

No. Using the Glycemic Index to choose foods is **only one** part of healthy eating.

Healthy eating also means:

- ✓ Eating at regular times
- ✓ Choosing a variety of foods from all food groups
- ✓ Limiting sugars and sweets
- ✓ Reducing the amount of fat you eat
- ✓ Including foods high in fibre
- ✓ Limiting salt, alcohol and caffeine

Remember that checking your blood glucose before and 1 or 2 hours after a meal is the best way to know how your body handles the meal.

Know who to turn to

Printed October 2005

Check out the Canadian Diabetes Association website, **www.diabetes.ca**, for more information.

CANADIAN DIABETES ASSOCIATION | ASSOCIATION CANADIENNE DU DIABÈTE

A lot of starchy foods have a high Glycemic Index (GI). Choose medium and low GI foods more often.

Low GI (55 or less)* choose most often ✓✓✓	**Medium GI** (56-69)* choose more often ✓✓	**High GI** (70 or more)* choose less often ✓
BREADS: 100% stone ground whole wheat Heavy mixed grain Pumpernickel	**BREADS:** Whole wheat Rye Pita	**BREADS:** White bread Kaiser roll Bagel, white
CEREAL: All Bran™ Bran Buds with Psyllium™ Oatmeal Oat Bran™	**CEREAL:** Grapenuts™ Shredded Wheat™ Quick oats	**CEREAL:** Bran flakes Corn flakes Rice Krispies™ Cheerios™
GRAINS: Parboiled or converted rice Barley Bulgar Pasta/noodles	**GRAINS:** Basmati rice Brown rice Couscous	**GRAINS:** Short-grain rice
OTHER: Sweet potato Yam Legumes Lentils Chickpeas Kidney beans Split peas Soy beans Baked beans	**OTHER:** Potato, new/white Sweet corn Popcorn Stoned Wheat Thins™ Ryvita™ (rye crisps) Black bean soup Green pea soup	**OTHER:** Potato, baking (Russet) French fries Pretzels Rice cakes Soda crackers

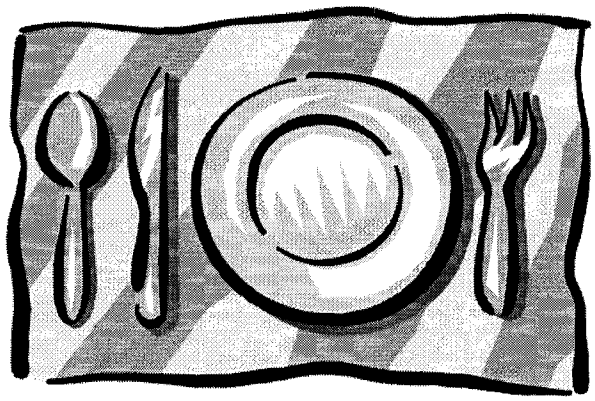
*expressed as a percentage of the value for glucose †Canadian values where available

Adapted with permission from Foster-Powell K, Holt SHA, Brand-Miller JC. International table of glycemic index and glycemic load values Am J Clin Nutr 2002;76:5-7&

110118 03-179 10/05 Q-2.5M

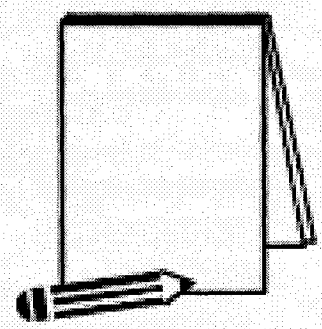
One change I will make **now** is _____

Glycemic Index Explained



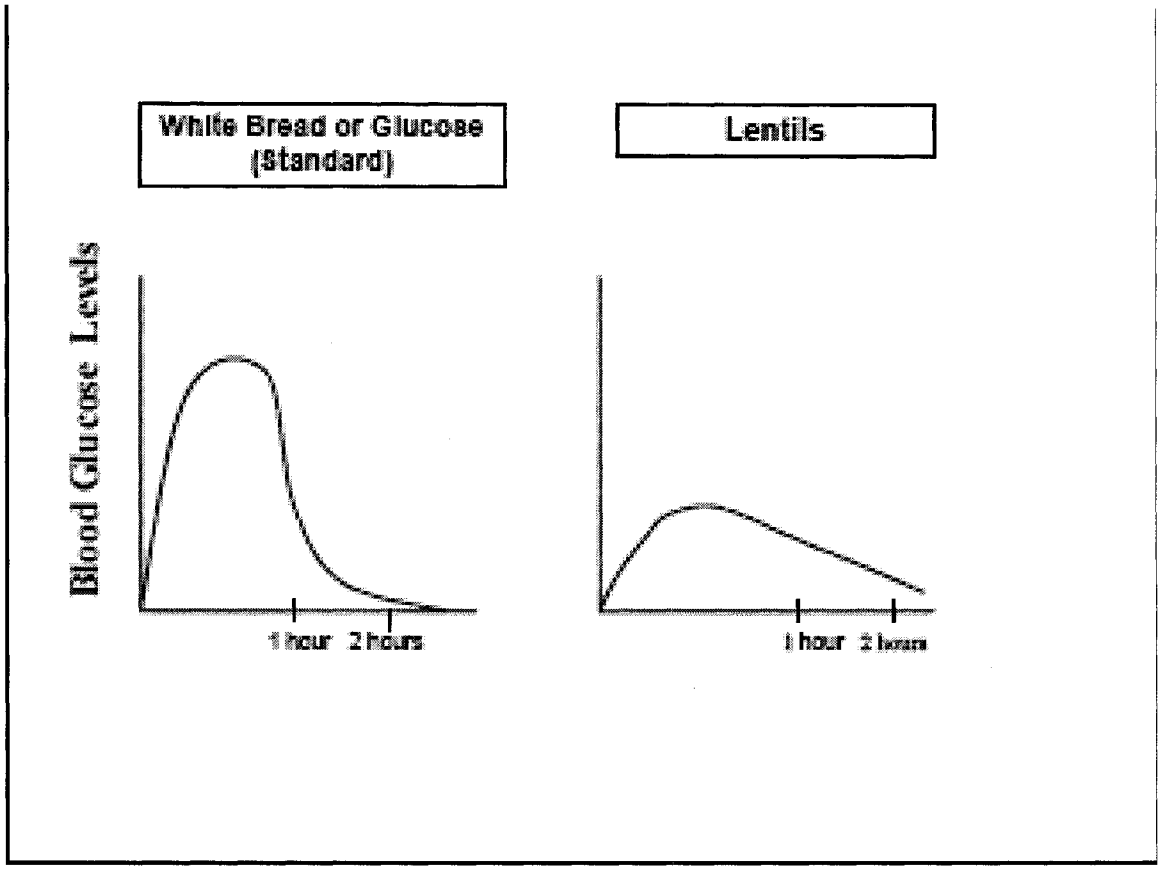
Let's discuss...

- Glycemic Index
  - What does it mean?
  - Factors that influence the glycemic index rating
  - Factors that influence our body's glycemic response
- Possible benefits to health
- What to eat!



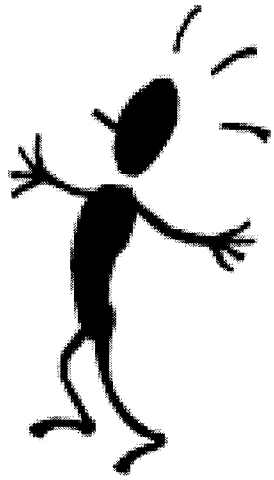
The Glycemic Index (GI)

- A scale that ranks carbohydrate-rich foods by how much they raise blood glucose levels compared to a standard food.



Factors Influencing GI Rating

- Type of starch
- Cooking
- Food processing
- Fat content of the food
- Acid content of the food



Cooking

- Cooking can **increase** the GI rating of a food
- Cooking swells starch molecules and softens foods making it faster to digest

spaghetti, white
- Boiled 5 min: GI = 34
- Boiled 10 – 15 min: GI = 40

Type of Starch

Amylose vs. Amylopectin

Amylose	Amylopectin
•Molecules form tight clumps	•Molecules are more open
•Harder to digest	•Easier to digest
Lower GI Rating	Higher GI Rating

Processing

- Highly processed foods are digested faster and tend to have a higher GI rating

Cornflakes GI = 86

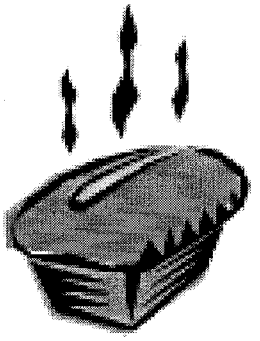
Porridge
(rolled oats) GI = 49

Processing

- For **unprocessed** grains the GI rating is lower because it takes longer to digest the food

pumpernickel bread GI = 46

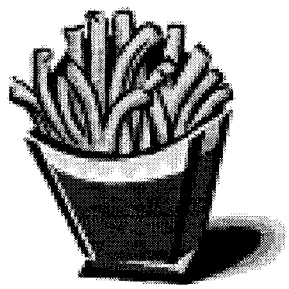
white bread GI = 73



Fat in Foods

- Foods with higher fat content have lower GI ratings. Fat content changes how your body digests foods.
- This shows that Low GI foods are not always the healthiest choice!

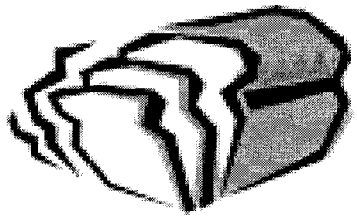
Potato chips GI = 75
Baked potato GI = 93



Acid in Foods

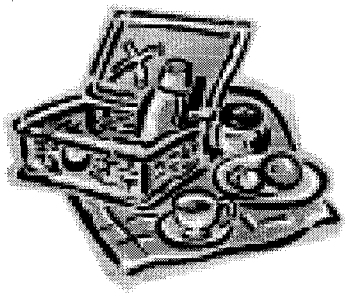
- Acids present in foods slow down your body digesting that food. Slower digestion means slower rise in blood glucose.

sourdough breads



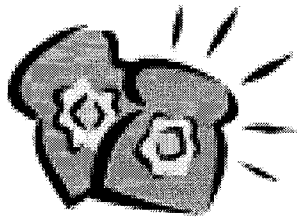
Factors Influencing the glycemic response

- Speed of stomach emptying
  - fat and protein
- Mixed meals



Speed of stomach emptying:
Fat and Protein

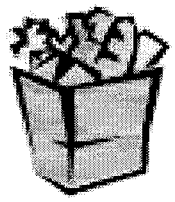
- Fat and protein slow the rate of stomach emptying
- Foods are digested at a slower rate
- Lower glycemic response



Eating foods with a low GI may help to

- Control blood glucose levels
- Control cholesterol levels
- Control appetite
- Decrease risk of heart disease
- Decrease risk of type 2 diabetes

What Should I Eat?



Remember:

Using the GI is only one part of healthy eating. Follow Canada's Food Guide when making food choices for overall good health!

Eat at regular times

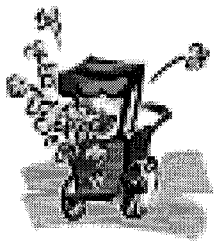
Limit sugar and sweets

Decrease fat intake

Include high fibre foods

Limit salt, alcohol and caffeine

The Glycemic Index



Lower GI ideas

Popcorn (55)

Boiled new potatoes (56)

Pear (38)

Plums (39)

Peach (42)

Milk (42)

Yogurt (30 to 40)

Higher GI foods

Pretzels (89)

Soda crackers (74)

French fries (75)

Baked potato (93)

Watermelon (72)

Tips to include low GI foods

1. **Enjoy** vegetables, fruits and low fat milk with your meals.
2. **Choose** one low GI food per meal
3. **Plan** menus around low GI food choices like lentils, barley and couscous.
4. **Exchange** high GI breads and cereals for lower GI alternatives

Appendix E:

Basic program
lifestyle workbook and resource manual

THE GLYCEMIC INDEX

Healthy eating is important for preventing and managing diabetes. But knowing what to eat is sometimes hard to understand. You will learn about how glycemic index or "GI" will fit into the management of your diabetes

Understanding which foods to choose is sometimes confusing. Taking part in this program will help you to understand the concept of glycemic index and how it can be used for people with diabetes.

EATING DIFFERENTLY:

Changing your eating habits might be difficult. How might you benefit from paying attention to the foods you eat and what are some of the changes you might need to make in order to eat differently?

GAINS for me	Gains for others

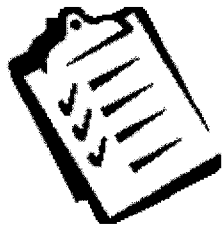
What obstacles might you encounter when changing your diet?

WHY FOCUS ON GLYCEMIC INDEX?

Many studies have shown people have better control of their blood sugar, lipids and body weight when they consume low glycemic index (low GI) foods.

Now that you have experience with active living for diabetes management, we will include healthy eating to the program in a similar way you have done with your walking. You will learn about the concept of GI, examples of low and high GI foods, and how to include low GI into your meal plan.

You will learn how to keep track of the number of low GI foods you eat each day using the **"GI TRACK"**. You will learn how to identify the low GI foods you eat and you will learn to set goals to eat more low GI foods.



IS THERE A RIGHT OR WRONG NUMBER OF LOW GI FOODS I SHOULD EAT?

The more low GI foods you eat, the better the benefits for managing your diabetes.

The Canadian Diabetes Association recommends choosing more low GI foods versus high GI foods.

WHERE SHOULD I START?

Good question. The best thing to do is to find out how many low GI foods you eat.

I ate an average of _____ low GI foods/day.

IS THIS GOOD OR BAD?

The more low GI foods you eat during the day the better.

HOW WILL I KNOW WHAT LOW GI FOODS I EAT?

You will learn to identify your low GI food choices for each meal.

Here are some examples of the low GI foods you consumed:

Breakfast	Lunch
Supper	Snacks

SO, HOW CAN I INCREASE MY LOW GI FOODS?

What meal do you think you can eat low GI foods?

What are some things you might plan to do to eat more low GI foods/day?

Who might help you to increase your low GI foods/day? How could they help you?

SETTING LOW GI GOALS - WEEK 1

Date:_____

My average 3-day intake of low GI food was _____.

I will increase this by + _____low GI foods/day

My new daily goal is _____ low GI foods/day

Write down one or two examples of low GI foods and the plan(s) you will use to meet your goal low GI goal.

My low GI foods	Plans to eat these foods

How confident are you that you can stick to your daily low GI 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 low goal?

0 1 2 3 4 5 6 7

WEEK 2

HOW DID YOU DO LAST WEEK?

How many days did you meet your low GI goal during the past week?_____

How many low GI foods did you eat over the week?_____; divide this number by the number of days you used the "GI TRACK" to get your average low GI foods/day

WHAT WORKED?

On the days you had more low GI foods/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

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

_____

_____

_____

Did the GI TRACK help you when consuming low GI foods?

Y N

WEEK 2

WHO HELPED YOU?

Did you tell anyone you about low GI foods?

Y N

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

Y N

How can your friends, co-workers or family help you to consume more low GI foods?

DON'T FORGET TO WALK!

Continue to meet your daily steps goals; you might need to adjust your goals.

I plan to take_____ steps/day this week.

Lets go for a short walk.

SETTING GOALS - WEEK 2

Date:_____

My average 3-day intake of low GI food was _____.

I will increase this by + _____low GI foods/day

My new daily goal is _____ low GI foods/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

Did you identify any new low GI foods that fit into your diet?

Y N

How confident are you that you can stick to your daily low GI 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 low goal?

0 1 2 3 4 5 6 7

WEEK 3

HOW DID YOU DO LAST WEEK?

How many days did you meet your low GI goal during the past week?_____

How many low GI foods did you eat over the week?_____; divide this number by the number of days you used the "GI TRACK" to get your average low GI foods/day

WHAT WORKED?

On the days you had more low GI foods/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

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

_____

_____

_____

Did the GI TRACK help you when consuming low GI foods?

Y N

WEEK 3

WHO HELPED YOU?

Did you tell anyone you about low GI foods?

Y N

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

Y N

How can your friends, co-workers or family help you to consume more low GI foods?

DON'T FORGET TO WALK!

Continue to meet your daily steps goals; you might need to adjust your goals.

I plan to take_____ steps/day this week.

Lets for a short walk.

SETTING GOALS - WEEK 3

Date:_____

My average 3-day intake of low GI food was _____.

I will increase this by + _____low GI foods/day

My new daily goal is _____ low GI foods/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

Did you identify any new low GI foods that fit into your diet?

Y N

How confident are you that you can stick to your daily low GI 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 low goal?

0 1 2 3 4 5 6 7

WEEK 4

HOW DID YOU DO LAST WEEK?

How many days did you meet your low GI goal during the past week?_____

How many low GI foods did you eat over the week?_____; divide this number by the number of days you used the "GI TRACK" to get your average low GI foods/day

WHAT WORKED?

On the days you had more low GI foods/day, what did you do?

_____

_____

_____

WHAT DIDN'T WORK?

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

_____

_____

_____

Did the GI TRACK help you when consuming low GI foods?

Y N

WEEK 4

WHO HELPED YOU?

Did you tell anyone you about low GI foods?

Y N

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

Y N

How can your friends, co-workers or family help you to consume more low GI foods?

DON'T FORGET TO WALK!

Continue to meet your daily steps goals; you might need to adjust your goals.

I plan to take_____ steps/day this week.

Lets go for a short walk.

SETTING GOALS - WEEK 4

Date:_____

My average 3-day intake of low GI food was _____.

I will increase this by + _____low GI foods/day

My new daily goal is _____ low GI foods/day

Write down one or two plans you will use to meet your goal.

_____

_____

_____

Did you identify any new low GI foods that fit into your diet?

Y N

How confident are you that you can stick to your daily low GI 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 low goal?

0 1 2 3 4 5 6 7

WEEK 6

HIGH RISK SITUATIONS

There may be many times when choosing low GI foods might be hard to do. The list below provides some common examples.

High risk situations when choosing low GI foods

Weekends	Eating out	Work
Holidays	Travel	Busy times

What are some of your high risk situations?

_____

_____

_____

If you had trouble when choosing low GI foods, what helped you get back on track?

_____

_____

_____

Did anyone help you stay on track?

Y N

If you answered YES, please write down who helped you:_____

RECORDING YOUR LOW GI FOODS

Daily:

- At the start of each week write in your low GI goal and you goal steps/day
- Each night, write down the number of low GI foods from your GI TRACK and the steps you took during the day
- If you meet the goal, check the star when you met your low GI goal and the box for your step goal.

Weekly:

- Count the number of check marks for low GI and for steps for the week
- Add-up all the number of low GI servings you had and add all the steps you took during the week
- Divide the total of low GI servings by the number of days you had low GI foods then add all the steps and divide by the number of days you wore the pedometer to get your new average steps/day.

Appendix F:

Enhanced lifestyle workbook with Step Cards and GI-cards

Setting Intensity Goals – Picking Up the Pace

Think 10%

Here is an example of how to calculate your walking intensity goals.

Ex.

I took **3000 steps** (from PUP pedometer) in **30 minutes** (from your stopwatch)

My **Picking Up the Pace** goal is:

3000 steps x 0.10 = 300 steps

Therefore, I will take 300 more steps than what I normally take

3000 + 300 = 3300 steps in 30 minutes

You try it:

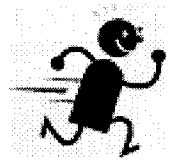
I take _____ steps in 30 minutes

My new **PUP** goal is:_____ steps in 30 minutes.

Helping you to set PUP Goals

If walking for 30 minutes is not possible, try splitting your 30 minutes into 3 x 10 minute bouts or 2 x 15 minute bouts.

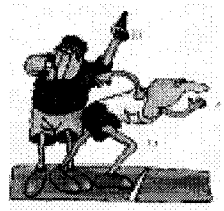
Increasing walking speed by 10 %:



During a 10 minute walk, I will take _____ steps

During a 15 minute walk, I will take _____ steps

GETTING STARTED



DURATION GOAL – ***30 minutes*** intentional walking for ***3 days/week***

INTENSITY GOAL - set your own goal for the number of steps you will take during **30 minutes of walking on 3 days.**

SETTING GOALS - WEEK 1

Date:_____

This week I took _____steps in 30 minutes.

My new PUP goal is + _____steps/30 mins

Please answer the following questions related to your goals for the **next week**

How confident are you that you can meet your daily 30 minute duration goal *during* the next week (please circle one).

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

How confident are that you will meet your speed goal (please circle one).

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

WEEK 2

HOW DID YOU DO?

ALL DAY STEPS

How many ALL DAY steps did you take during the week?_____

My average steps/day = total days divided by the total number of steps (from above) _____

PUP STEPS

How many PUP steps did you take during the week?_____

How many PUP minutes did you have during the week? _____

How many days were you able to meet your PUP goal?_____

My average PUP steps = total minutes divided by total PUP steps are_____

WHAT WORKED?

On your PUP days, what did you do?

_____

_____

WHAT DIDN'T WORK?

What made it difficult for you to get your PUP steps?

_____

_____

WEEK 2

THE WEEK AHEAD

Remember:

DURATION GOAL – ***30 minutes*** intentional walking for ***3 days/week***

INTENSITY GOAL - set your own goal for the number of steps you will take during **30 minutes of walking on 3 days.**

ALL DAY STEPS - continue to meet your daily total step goal

Please answer the following questions related to your goals for the

How confident are you that you can meet your daily 30 minute duration goal *during* the next week

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

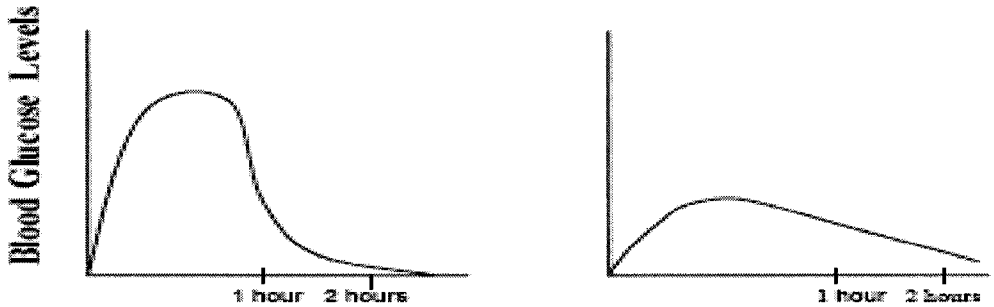
How confident are that you will meet your speed goal (please circle one).

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

WEEK 3

THE GLYCEMIC INDEX

Did you know your blood sugar goes up after you eat?



Healthy eating is important for preventing and managing diabetes. But knowing what to eat is sometimes hard to understand.

You will learn about how glycemic index or "GI" will fit into the management of your diabetes.

Understanding which foods to choose is sometimes confusing.

Taking part in this program will help you to understand the concept of glycemic index and how it can be used for people with diabetes.

The more low GI foods you eat, the better the benefits for managing your diabetes.

The Canadian Diabetes Association recommends choosing more low GI foods versus high GI foods.

WEEK 3

EATING DIFFERENTLY:

Changing your eating habits might be difficult. How might you benefit from paying attention to the foods you eat and what are some of the changes you might need to make in order to eat differently?

WHAT ARE GUSHERS & LEAKERS?

LEAKERS	GUSHERS
Low Glycemic Index	**High Glycemic Index**
Higher - fibre	**Lower-fibre**
Lower blood sugar after you eat	**Higher blood sugar after you eat**

Try to replace GUSHERS with LEAKERS

WEEK 3

HOW CAN I IDENTIFY LEAKERS & GUSHERS?

STEP 1: WHAT ARE MY CARBOHYDRATE FOODS?

IDENTIFY THEM BY YOUR MOST RECENT MEALS

MY GUSHERS	MY LEAKERS
Breakfast: **Toast – white bread** **Cheerios**	**Breakfast:** **Oatmeal** **Toast - whole wheat bread**
Lunch: **French fries** **Hamburger bun (white)**	**Lunch:** **Whole wheat pasta** **Salad**
Dinner: **Coke** **Baked Potato**	**Dinner:** **Basmati rice** **Skim milk**
Snack: **Pretzels** **Rice cakes**	**Snack:** **Stoned wheat thins**

Unsure:_____

_____

WEEK 3

SETTING YOUR DAILY GI GOALS

TARGET 3 DAYS/WEEK

USING THE "GOOD – BETTER – BEST PRINCIPLE"

A **GOOD** GI-DAY?

When you replace 1 GUSHER with 1 LEAKER

A **BETTER** GI-DAY?

When you replace 2 GUSHERS with 2 LEAKERS

The **BEST** GI-DAY?

When you replace 3 GUSHERS with 3 LEAKERS

Recording you GI day:

Side 1

GI CARD

I replaced this GUSHER				**With this LEAKER**		
Day	1	2	3	Week	1	2

Side 2

What kind of a GI day did you have?			
GOOD	√		
BETTER	√		√
BEST	√	√	√

WEEK 3

SO, HOW CAN I EAT MORE LEAKERS?

What meal do you think you can eat LEAKERS?

_____

_____

_____

What are some things you might plan to do to eat more LEAKERS?

_____

_____

_____

Who might help you to eat more LEAKERS? How could they help you?

_____

_____

_____

WEEK 3

SETTING GI GOALS

Date:_____

This week I will have _____ GI days.

DON'T FORGET YOUR STEPS FROM LAST WEEK

HOW DID YOU DO?

ALL DAY STEPS

How many ALL DAY steps did you take during the week?_____

My average steps/day = total days divided by the total number of steps (from above) _____

PUP STEPS

How many PUP steps did you take during the week?_____

How many PUP minutes did you have during the week? _____

How many days were you able to meet your PUP goal?_____

My average PUP steps = total minutes divided by total PUP steps are_____

WEEK 4

HOW DID YOU DO?

GUSHERS & LEAKERS

How many GUSHERS did you replace with LEAKERS?_____

WHAT WORKED?

On your GI days, what did you do?

_____

_____

WHAT DIDN'T WORK?

What made it difficult for you to get your more LEAKERS?

_____

_____

ALL DAY STEPS

How many ALL DAY steps did you take during the week?_____

My average steps/day = total days divided by the total number of steps (from above) _____

PUP STEPS

How many PUP steps did you take during the week?_____

How many PUP minutes did you have during the week? _____

How many days were you able to meet your PUP goal?_____

My average PUP steps = total minutes divided by total PUP steps are_____

WEEK 4

What can you do to give you the BEST GI days?

_____

_____

Who can help you to give you the BEST GI days and how can they help you ?

_____

_____

SETTING GI GOALS

Date:_____

This week I had _____ GI days.

I plan to have _____GI days over the next week

How confident are you that you can stick to your GI 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 GI goal?

0 1 2 3

RECORDING YOUR STEPS & GI DAYS

Daily:

- At the start of each week write in your
  1) goal steps/day
  2) your PUP step goals
  3) your GI goals

- Each night, write down the total number of ALL DAY steps you took during the day

- If you meet the goal, check the box beside the box for ALL DAY steps.

Weekly:

- Count the number of check marks for the week

- Add-up the total number of ALL DAY steps you took during the week.

- Divide the total steps by the number of days you wore the pedometer to get your new average steps/day.

- Transfer your PUP steps from your STEP CARD to your calendar.

- Transfer your good, better or best definitions to your calendar from your GI CARDS (see below).

Side 1

HEALD - STEP CARD

My PUP STEP goal = _____steps/30min

Today I took _____PUP STEPS

My total PUP minutes for today = _____

Did you meet your PUP STEP goal ? Y N

DAY # WEEK #

HEALD - STEP CARD

My PUP STEP goal = _____steps/30min

Today I took _____PUP STEPS

My total PUP minutes for today = _____

Did you meet your PUP STEP goal ? Y N

DAY # WEEK #

Side 2

My ALL DAY STEP goal = _____

I took _____ALL DAY STEPS

Rate how hard your PUP walking was today

very easy	moderately hard	very hard
6 7 8 9 10	11 12 13 14 15	16 17 18 19 20

My ALL DAY STEP goal = _____

I took _____ALL DAY STEPS

Rate how hard your PUP walking was today

very easy	moderately hard	very hard
6 7 8 9 10	11 12 13 14 15	16 17 18 19 20

Appendix G:

Additional data collected from The Healthy Eating and Active Living for Diabetes (HEALD) Study (Chapter 5)

Personal Factors Associated with Consuming Low Glycemic Index Foods in Type 2 Diabetes. *STEPHANIE THOMAS, STEVE JOHNSON, TANYA BERRY, RHONDA BELL. University of Alberta. Alberta, Canada.

Background/Objective. Consuming a low glycemic index (GI) diet has been proposed as an effective means to enhance glycemic control in type 2 diabetes (T2D). There is little evidence, however, describing how to facilitate the consumption of a reduced GI diet. Thus, the objective of this study was to determine what personal factors were associated with consuming a low GI diet following a 12 week lifestyle intervention.

Methods. Thirty-three participants (55% female; age 57.8 ± 6.7; BMI 32.3 ± 6.5kg/m^2) were randomly allocated to either an enhanced (n= 17) or basic (n= 16) lifestyle program for diabetes management. Based on group allocation, participants were required to attend a one-hour lifestyle session once weekly for the first four weeks of the intervention. The basic group received general information about the GI concept and were encouraged to increase their daily consumption of low-GI foods. The enhanced group received the same general information but were instructed to exchange high-GI foods with low-GI foods. Before and after the intervention, participants completed a GI Questionnaire (GIQ) which contained 6 domains: Glycemic Index Knowledge, Concerns, Glycemic Control, Weight Management, Energy Level and Exercise, and Lifestyle Change. A total score for each domain was calculated and a group average was generated for comparison. A 3-day food record was completed before and after intervention.

Results. Knowledge and weight management scores increased for both groups ($P<0.05$). An overall reduction in total energy, fat, carbohydrate, glycemic index and load were observed ($P<0.05$). No group differences were found for GIQ scores or dietary intake.

Conclusion. Providing general guidelines to improve dietary GI may be just as effective as the provision of a more enhanced message for improving GI knowledge among people with T2D. Moreover, when considering dietary counselling, improved knowledge of GI may be an important target to facilitate positive behaviour modification for disease management.

Table 1. Changes in Mean Domain Score on the Glycemic Index Questionnaire in Basic and Enhanced Groups after a 12 week Lifestyle Intervention.

	Week 12		Week 24	
Questionnaire Domain	Basic	Enhanced	Basic	Enhanced
Knowledge (4-20)†	12.1 ± 4.7	12.7 ± 3.6	15.3 ± 2.7*	16.6 ± 1.0*
Concerns (7-35) †	9.3 ± 3.5	8.9 ± 4.6	9.2 ± 1.7	9.8 ± 4.1
Glycemic Control (3-15) †	8.1 ± 1.8	7.7 ± 1.9	8.1 ± 1.1	7.2 ±1.7
Weight Management (2-10) †	6.8 ± 1.4	7.3 ± 2.1	8.2 ±1.0*	8.1 ±1.6*
Energy Level and Exercise (2-10) †	6.5 ±1.6	7.2 ± 2.2	7.3 ± 1.6	7.3 ± 1.7
Lifestyle Change (3-15) †	12.9 ± 2.1	13.2 ± 2.5	13.8 ± 1.6	13.6 ±1.7

Data is presented as mean ± SD

*Statistically significant difference ($p \leq 0.05$)

†Numbers in brackets under domain name indicate the possible range of scores for each domain.

Week 12: Basic (n=16) Enhanced (n=17)Week 24: Basic (n=16) Enhanced (n=17)

Glycemic Index Questionnaire (GIQ)

HEALD-Healthy Eating Active Living for Diabetes

Name: _____ **Date:**_____

Please check the best answer according to your thoughts on selecting low Glycemic Index foods.

Glycemic Index Knowledge					
	Very Poor	**Poor**	**Unsure**	**Good**	**Very Good**
How would you describe your knowledge of the glycemic index?					
What is your confidence level when identifying low glycemic index foods?					
What is your confidence level for regularly consuming low glycemic index foods?					
How good are low glycemic index carbohydrates for your health?					
When Choosing Low Glycemic Index Foods I am Concerned:					
	Almost never	**Less than half of the time**	**Half of the time**	**Over half of the time**	**Almost always**
I will have gastrointestinal (digestive) problems.					
They will take too long to prepare.					
They will cost too much.					
They will taste bad.					
My family or friends won't approve.					
I won't know how to prepare them.					
The choice is limited.					

Please check the best answer to indicate your thoughts on the following statements

Glycemic Control					
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Eating low-glycemic index foods improves blood sugar readings.					
I am afraid eating low-glycemic index foods will cause high blood sugar readings.					
I am afraid eating low-glycemic index foods will cause low blood sugar readings.					
Weight Management					
Eating low-glycemic index foods will help with weight management.					
Eating low-glycemic index foods will decrease my hunger between meals.					
Energy Level and Exercise					
Eating low glycemic index foods will give me more energy.					
Eating low glycemic index foods will help me to be more physically active.					
Lifestyle Change					
Lifestyle change, rather than "going on a diet", is the most effective way to better manage my diabetes.					
Choosing low glycemic index foods is a lifestyle change that helps to better manage my diabetes.					
Choosing low glycemic index foods as a permanent lifestyle change to better manage my diabetes is an achievable goal.					

HEALD – Health Related Quality of Life Questionnaire

INSTRUCTIONS: This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do you usual activities.

Please answer every question by marking one box. If you are unsure about how to answer, please give the best answer you can.

1. In general, would you say your health is:

☐	☐	☐	☐	☐
Excellent	**Very good**	**Good**	**Fair**	**Poor**

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes Limited a lot	**Yes, Limited a little**	**No, not limited at all**
2. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐	☐	☐
3. Climbing **several** flights of stairs	☐	☐	☐

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of you physical health?

	Yes	**No**
4. **Accomplished less** than you would like	☐	☐
5. Were limited in the **kind** of work or other activities	☐	☐

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

		Yes	No
6.	**Accomplished less** than you would like	☐	☐
7.	Didn't do work or other activities as **carefully** as usual	☐	☐

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

☐	☐	☐	☐	☐
Not at all	**A little bit**	**Moderately**	**Quite a bit**	**Extremely**

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks -

	All of the time	Most of the time	A good bit of the time	A little of the time	None of the time
9. Have you felt calm and peaceful?	☐	☐	☐	☐	☐
10. Did you have a lot of energy?	☐	☐	☐	☐	☐
11. Have you felt downhearted and blue?	☐	☐	☐	☐	☐

12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

☐	☐	☐	☐	☐
All of the time	**Most of the time**	**Some of the time**	**A little of the time**	**None of the time**

Appendix H:

The GI-track used in the Basic program

GI TRACK

√ CHECK each time you eat a low Glycemic Index food today

Today is:_____

Grain Products ☐ ☐ ☐ ☐ ☐ ☐

(Heavy mixed grain bread, pumpernickel, All Bran cereal, Bran Buds with psyllium, oatmeal, parboiled or long grain rice, barley, pastas/noodles, etc)

Vegetables & Fruit ☐ ☐ ☐ ☐ ☐ ☐

(Sweet potato, yam, peas, apple, orange, pears, grapes, plum, canned peaches in natural juice, unsweetened juices, tomato juice etc)

Milk products ☐ ☐ ☐ ☐ ☐

(Fruit yogurt, 1% and skim milk, soy milk etc)

More... ☐ ☐ ☐ ☐ ☐

(Lentils, chickpeas, kidney beans, split beans, baked beans etc)

Note: Use water soluble pen. Tally the total number of low GI foods/checkmarks, and record on your worksheet. Wipe and reuse.

Appendix I:

Scoring system used to calculate the carbohydrate score

THE CARBOHYDRATE SCORE – calculated as the average number of servings over 3-days based on a 3 day food record

Grain products

Score	0	1	2	3	4
Whole grains	<1portion/day	1-2 portions/day	3-4 portions/day	5-6 portions/day	≥ 7 portions/day
Refined grains	≥ 7 portions/day	5-6 portions/day	3-4 portions/day	1-2 portions/day	<1portion/day

All serving sizes were based on Canada's Food Guide to Healthy Eating (CFGHE)
Portion = 1 slice of bread, ½ cup (125 ml) of pasta, rice or couscous, 30 g for cereals (hot & cold)
If a full portion size was not reported, the proportion of each serving was calculated relative to a full serving according to CFGHE.

Vegetables

Score	0	1	2	3	4
Vegetables	<1portion/day	1 portion/day	2 portions/day	3 portions/day	≥ 4 portions/day
Vegetable Juice		Maximum 1 point			

Portion size = ½ cup (125 ml) of fresh frozen or 1 medium vegetable.
If one full portion size was not met, the proportion of each serving was calculated relative to a full serving according to CFGHE.
French fries were not included in this category.
The consumption of whole vegetables is preferable; therefore vegetables juice received a maximum of 1 point based on a minimum of ½ cup (125mL) serving averaged from the 3 day food records.

Appendix G [cont']

Fruits

Score	0	1	2	3	4
Fruits	<1portion/day	1 portion/day	2 portions/day	3 portions/day	≥ 4 portions/day
Fruit Juice		Maximum 1 point			

Portion size = ½ cup or 1 medium fruit.
If one full portion size was not met, the proportion of each serving was calculated relative to a full serving according to CFGHE.
The consumption of whole fruit is preferable; therefore, fruit juice received a maximum of 1 point based on a minimum of ½ cup (125mL) serving averaged from the 3 day food records.

Milk & Dairy

Score	0	1	2	3	4
Milk & Dairy	< 1portion /day or > 4 portions/day	4 portions/day		1 portion/day	2-3 portions/day

Portion size = 1 cup (250 ml) of milk, 50g of cheese or 175g yogurt.
A reciprocal score reflects consumption below or beyond the recommended number of portions recommended by CFGHE.

Food to be consumed less often

Score	0	1	2	3	4
Less often	≥ 7 times over 3 days	5-6 times over 3 days	3-4 times over 3 days	1-2 times over 3 days	<1 over 3 days

Foods to limit as outlined by CFGHE are defined as foods high in calories, fat, sugar or salt (sodium) and are defined:

Cakes and pastries
Cookies and granola bars
Deserts
Chocolates and hard candies
Doughnuts and muffins
French fries
Nachos
Potato chips
Alcohol
Fruit flavoured drinks (not diet)
Soft drinks (not including diet)
Sport and energy drinks
Sweetened hot an cold beverages

Pulses & Legumes

Score	0	1	2	3	4
Pulses & Legumes	< 0.5 portions/day	0.5 portions/day	1 portion/day	2 portions/day	> 2 portions/day

Portion size = according to *CFGHE*, one portion size of pulses/legumes in the meat and alternatives is ¾ cup. Examples include: lentils, beans (kidney, chic peas black beans etc.)
If one full portion size was not met, the proportion of each serving was calculated relative to a full serving according to *CFGHE*.

Global Carbohydrate Score

Category	**Range**
Whole grains	0 to 4
Refined grains	0 to 4
Vegetable	0 to 4
Vegetable juice	0 to 1
Fruit	0 to 4
Fruit juice	0 to 1
Milk & dairy	0 to 4
To be consumed less often	0 to 4
Pulses & legumes	0 to 4
Global carbohydrate score	**0 to 30**

Appendix J:

Electronic Survey for Dietitians

Electronic Survey:

Active Living Recommendations as an Adjunct to Nutrition Counseling

Part 1: Demographic Information

Please answer the following questions about yourself and your current dietetic practice.

1. Age: _____ years.

2. Gender:

☐ Male ☐ Female

3. Years practicing as a registered dietitian: _____

4. Current job title: _____

5. Where do most of your clients live?

☐ Urban area ☐ Rural area

6. What type of work setting do you practice in? **(Please check all that apply)**

☐ Public Health Centre
☐ Fitness/recreational club or facility
☐ Government
☐ Industry
☐ Not for profit organization
☐ Occupational health/corporate wellness
☐ School or school board
☐ Education institution
☐ Food service and hospitality
☐ Extended or long-term care
☐ Medical clinic
☐ Private practice/consulting
☐ Hospital

7. What age group(s) do you counsel most often? **(Please check all that apply)**

☐ Infants (0-2 years)
☐ Preschool children (3-4 years)
☐ School age children (5-12 years)
☐ All children (0-12 years)
☐ Youth (13-17 years)
☐ Adults (18-65 years)
☐ Seniors (65+ years)
☐ All ages

8. What types of nutrition issues do you counsel on most frequently? **(Please check all that apply)**

☐ Clinical nutrition for disease treatment or management (e.g. Celiac disease, cancer, burns, food allergies, heart, renal or liver disease, etc.)
☐ Obesity/weight control/healthy weight

☐ Athletic performance/sport nutrition	☐ Psychiatry/mental health (including eating disorders)
☐ Diabetes/glucose intolerance	☐ Healthy eating/general nutrition
☐ Vegetarianism	☐ Preconception/pregnancy nutrition

9. Are you physically active?

☐ Yes	☐ No (if no, please go to Part 2 of the survey)

10. How often do you participate in some form of physical activity?

☐ Daily	☐ < 1 time per week
☐ < 3 times per week	☐ Never participate
☐ 3 – 4 times per week	

11. Describe the types of physical activity you participate in:

Part 2: Physical Activity/Active Living Questions

Please answer the following questions based on your own dietetic practice.

12. I currently discuss strategies to promote physical activity/active living with the client(s) that I work with.

☐ Yes
☐ No (If no, please go to question 16)

13. I have counseled client(s) about physical activity/active living for the following period of time:

☐ < 1 year ☐ 1-2 years
☐ 3-5 years ☐ > 5 years

	Never	Some of the Time	Most of the Time	Always
14 (a). I assess clients for their stage of readiness (e.g. transtheoretical model; stages of change) for physical activity/active living.	1	2	3	4
14 (b). I develop strategies appropriate for the stage of readiness (e.g. transtheoretical model; stages of change) that my clients are in.	1	2	3	4
14 (c). I use Canada's Physical Activity Guide as a resource in my counseling.	1	2	3	4
14 (d). I recommend various tools (such as pedometers, diaries or other techniques) for assessment and self-monitoring of physical activity/active living to my clients.	1	2	3	4
14 (e). I provide my clients with specific instruction on the use of tools (such as pedometers, diaries or other techniques) for self-assessment and self-monitoring of physical activity/active living.	1	2	3	4
14 (f). I develop care plans or programs for my clients that include recommendations for physical activity/active living.	1	2	3	4
14 (g). I use a referral system with physical activity professionals.	1	2	3	4

14 (h). ***Please respond to this question only if you use a referral system with physical activity professionals. If you do not use a referral system, please go to question 15.***

Please describe the physical activity professionals you work with as part of your referral system (e.g. job title, educational background, qualifications or skill base, work site or practice setting):

15. If you wish, please expand on the specific programs, activities, resources focusing on physical activity/active living that you are currently using in your practice:

16. Last spring, 2002, I attended one of the Active Living Workshops for Dietitians held in Alberta.

☐ Yes
☐ No

☐ Submit Survey ☐ Cancel

Thank you for participating in this survey! Your E-mail address will automatically be entered into a random draw for three possible prizes (gift certificates valued at $100, $75, and $50).

Rest assured that your personal information and survey responses will be held in confidence. Once the prize draw is completed, your E-mail address will be deleted from our files. Your responses to the survey will be stored using a unique numerical identifier. Only our technical consultant will have the master list that matches personal information provided on the consent form with the responses to the survey questions. The researchers will be blinded to this list.