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An Examination of Potential Influences on the Success of Prediabetes Service Provision

by

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ABSTRACT

Introduction: Several national trials have demonstrated the efficacy of lifestyle interventions on decreasing the incidence of type 2 diabetes in adults with prediabetes. Behavior change pertaining to physical activity (PA) and diet were central to these lifestyle interventions; however it is likely a majority of adults with prediabetes are not currently meeting public health guidelines for PA and dietary intake. Little information is available on different influences of behavior central to prediabetes treatment. Given these findings, further investigation into potential influences on the efficacy of prediabetes service provision is warranted.

Purpose: This dissertation aimed to explore prediabetes service provision to identify potential influences on PA and dietary intake in adults with prediabetes.

Methods: The first study used Grounded Theory methodology to obtain opinions on necessary components of an optimal diabetes prevention program from health professionals' (n=20) and adults with, or at high risk of, prediabetes (n=12). The second, third, and fourth studies involved individuals with prediabetes (N=232) in Northern Alberta, Canada. Participants completed a mailed survey assessing various demographic, health and behavior influences in August-September, 2008.

Results: Data from Study 1 identified four influences on behavior change in adults with prediabetes: service provision, knowledge or confusion, motivational influences, and goal-setting. Potential strategies to increase effectiveness of prediabetes programs were also identified. In Study 2, individuals with prediabetes achieving PA guidelines (38%) reported higher physical and mental health-related quality of life compared to those not meeting PA guidelines. In Study 3, a number of preferences for PA and PA programming were identified. Activity status, health, and demographic variables all demonstrated significant

influence on different PA preference variables. In Study 4, behavior-specific social cognitive theory constructs including self-efficacy, outcome expectations, and goal formation demonstrated significant associations with each other and PA, fat, and fibre intake.

Conclusions: Evidence suggests it is possible to prevent or delay the progression of prediabetes to diabetes with small changes in body weight, physical activity and dietary intake. The results reported in this dissertation identified a number of factors that may influence potential success of a prediabetes program to promote behavior change and increase the public health impact of prediabetes prevention programs.

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Gloria Deo, omnis laus et honor sunt Eius: Glory to God, all glory and honor are his.

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LIST OF SYMBOLS, NOMENCLATURE, AND ABBREVIATIONS

T2D	Type 2 diabetes
PA	Physical activity
HRQoL	Health-related quality of life
SCT	Social cognitive theory
IGT	Impaired glucose tolerance
IFG	Impaired fasting glucose
BMI	Body mass index
G	Gram
DPS	Finnish diabetes prevention study
DPP	American diabetes prevention program
IDPP-1	Indian diabetes prevention programme
RCT	Randomized controlled trial
Kcal	Kilocalories
MOH	Medical officer of health
AusDiab	Australian diabetes, obesity and lifestyle study
CCM	Chronic care model
HbA_{1C}	Haemoglobin A_{1C}
CVD	Cardiovascular disease

CHAPTER 1:

Introduction

Primary prevention of type 2 diabetes (T2D) is an urgent public health concern [1-3]. In Canada, the World Health Organization is projecting a 57% rise in prevalence of diabetes by the year 2030 [4]. Individuals who have prediabetes are likely to develop T2D in the absence of any intervention over time [25-26]. No Canadian data are available documenting the prevalence of prediabetes in the adult population; however, in the United States, it is estimated that between 25%-40% of adults aged ≥ 40 have been diagnosed with prediabetes [5-6]. Prevalence estimates in other countries are similar. For example, between 15%-34% of individuals in Denmark have prediabetes, and between 17%-30% of Australians have prediabetes [7-8].

Several national trials have demonstrated the efficacy of lifestyle interventions on decreasing the incidence of T2D diabetes. Specifically, if adults with prediabetes achieved and maintained a small weight reduction (i.e., ~5%), they decreased their risk of developing T2D by approximately 58% over a four-year period [9-10]. Over the long-term, (i.e., 20-year, 10-year, and 7-year follow-up) these studies demonstrated a 34%-43% reduction in the risk of developing T2D in the lifestyle intervention groups compared to the control groups [11-13]. Behavior change pertaining to physical activity (PA) and diet were central to these lifestyle interventions. Specifically, adults with prediabetes who engaged in moderate-intensity PA for 30 minutes daily, reduced their fat intake to less than 30% of calories, and increased their intake of fibre to 15 grams (g)/1000 kilocalories (kcal), were more likely to lose and maintain weight loss over time. Data also indicated these lifestyle changes may independently reduce or delay the risk of developing T2D even in the absence of continued weight loss [13-15].

Unfortunately, diabetes prevention programs, while efficacious, have had limited applicability within community settings [16]. Further, information is lacking

regarding how to offer practical community-based diabetes prevention programs that can be offered to large segments of the target population, are efficacious, are acceptable to healthcare organizations, can be implemented consistently and whose effects can be maintained over time [17]. To increase the public health impact of diabetes prevention research multiple influences on behavior need to be assessed and targeted [18-19].

Much of the research in diabetes prevention appears to have targeted individuals without considering health behavior theory and the contextual, social, community, cultural or environmental influences on PA and dietary behaviors [20]. There is very little information available on these different influences and their relationship to PA and dietary behaviors that are a cornerstone in prediabetes treatment. The Precede-Proceed model is an ecological health promotion framework that guides the assessment of multiple influences and factors in program development [21]. The assessment portion of this model (Precede) investigates four distinct components: social assessment, epidemiological assessment, educational and ecological assessment and administrative and policy assessment [21]. Within each component different types of information are gathered in the target population(s). Different variables and their relationship to behavior that are typically explored include: quality of life; demographic, health and environmental influences; predisposing, reinforcing and enabling factors; and, organizational context (i.e., healthcare settings). Using the Precede component of this model to explore the provision of diabetes prevention services has the potential to provide valuable insight on variables that may impact PA, weight loss and fat and fibre intake in adults with prediabetes.

Objectives of the Dissertation

The purpose of this dissertation was to explore prediabetes service provision and identify potential influences on PA and dietary intake. Four studies were conducted using both qualitative and quantitative approaches to identify factors that may promote behavior change in those with prediabetes. The first, was a qualitative study employing Grounded Theory methodology, to obtain health professionals' and adults with prediabetes opinions on the necessary components of an optimal diabetes prevention program. The second, third and fourth studies were based on a quantitative cross-sectional survey involving individuals with prediabetes who had attended a 2-hour prediabetes education class in Edmonton, Alberta.

Study 1

Eliciting information on the preferred components of a lifestyle intervention from key stakeholders (i.e., adults with prediabetes and health care providers) is essential to developing efficacious programs that can be distributed to large segments of the population and are acceptable to healthcare organizations [17, 21]. Using qualitative research methods in this context may facilitate the elicitation of perceptions and recommendations from both the service provider and the service consumer regarding optimal service provision. In particular, no studies to date have applied Grounded Theory methodology to develop a framework that can be used to improve diabetes prevention programs. Therefore, the purpose of this study was to employ Grounded Theory methodology to identify and examine the optimal components of a prediabetes intervention program from the perspective of those with prediabetes, as well as healthcare professionals working with those with prediabetes within a specific

healthcare setting. For this study, the healthcare setting was the Edmonton region of Alberta Health Services.

Research Objectives

The research objectives in this study aimed to identify from the health professionals: 1) what health information is currently provided to clients diagnosed with prediabetes in the Edmonton region; 2) when is health information provided to clients diagnosed with prediabetes and what is the referral process to the prediabetes education class; 3) what health care professionals provide the majority of service to people with prediabetes; 4) what goals should be included in diabetes prevention programs and why or why not are these goals being met, and; 5) what barriers do health professionals perceive influence adults with prediabetes behavior change and prevent these adults from achieving lifestyle changes.

The research objectives in this study also aimed to identify from adults with prediabetes: 1) health information they had received; 2) type of prediabetes services they would consider optimal; and 3) facilitators and barriers they felt impacted their lifestyle changes.

Study 2

Despite the favorable effects PA has on both physical and psychological health in adults [22], little is known about the PA behaviors of individuals with prediabetes. No studies have examined the relationship between physical and mental functioning, including health-related quality of life (HRQoL) and meeting or not meeting prediabetes PA guidelines in adults with prediabetes. Although Bize et al. [23] report that both cross-sectional and randomized controlled trials demonstrate positive associations between PA and HRQoL, they advocate for

more research to be conducted examining these associations. Therefore, the objectives of this study were to determine the proportion of adults with prediabetes who were meeting prediabetes PA recommendations and to determine if any differences in HRQoL existed between individuals with prediabetes who are physically active compared to those who are insufficiently active.

Hypothesis

We hypothesized that individuals with prediabetes meeting PA guidelines would report higher HRQoL (i.e., physical and mental functioning) than those not meeting guidelines.

Study 3

In order to design a program to increase PA in adults with prediabetes, information on the PA preferences of this population is needed. Examining the PA preferences and factors related to PA preferences can facilitate the initiation and maintenance of PA [24-25], and aid clinicians and program planners to develop intervention tools, programs and strategies that appeal to individuals with prediabetes and encourage participation and engagement [26]. To our knowledge, no studies have examined the preferences of PA among the prediabetes population. Therefore, the primary objective of this study was to identify PA preferences in a sample of individuals with prediabetes. The second objective was to determine whether various demographic, health and PA variables were associated with individuals' PA preferences.

Hypothesis

Given the developmental and exploratory nature of this study no hypotheses were generated.

Study 4

When examining predisposing, reinforcing and enabling factors the authors of the Precede-Proceed model advise to use a health behavioral theory such as Social Cognitive Theory (SCT) as a guiding model [21]. It is through the implementation of behavioral theories, such as SCT, and thorough analyses of the potential moderators/mediators of behavior change (i.e., theoretical constructs) that researchers and practitioners can begin to understand how to develop and implement theoretically based programs that maximize opportunities for behavior change [19]. SCT contains a number of constructs that can be measured and are hypothesized to directly or indirectly affect behavior change [27]. Constructs from SCT, particularly self-efficacy, have been identified as important determinants of weight change and physical activity behavior in adults [28-30]. While SCT constructs appear to be important predictors of dietary intake and PA behavior in other populations, no studies have explored the role of SCT constructs in understanding fat and fibre intake as well as PA in a prediabetes population. Therefore, the primary objectives of this study were to investigate the role of SCT in understanding fat and fibre intake and PA in a sample of individuals with diagnosed prediabetes. The secondary objective was to describe current fat and fibre intake in adults with prediabetes.

Hypothesis

In this study it was hypothesized that self-efficacy (i.e.,low-fat diet, high fibre diet, task PA, coping PA and scheduling PA) would be significantly related to outcome expectations, goal formation and fat and fibre intake and leisure-time PA in individuals with prediabetes. We further hypothesized that goal formation and outcome expectations would be signficiantly related to fat and fibre intake and PA and that outcome expectations would be related to goal formation.

Practical Implications

The purpose of this dissertation was to identify factors that may influence the success of diabetes prevention programs. Identifying ingredients for diabetes prevention programs that promote lifestyle change within healthcare settings has the potential to enhance the current evidence base. The findings from these studies can be used to develop programs for people with prediabetes that potentially have greater public health applicability than the efficacy trials completed to date. Given the importance to public health of preventing or delaying future cases of diabetes, such research should continue to be a high priority.

Definitions

1. *Prediabetes* describes individuals who have impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) [3]. See Table 1: Plasma Glucose (PG) Levels for Diagnosis of IFG and IGT for diagnostic criterion [3].

Table 1: Plasma Glucose (PG) Levels for Diagnosis of IFG and IGT

	Fasting PG (mmol/L)		2 hour PG in a 75 g OGTT (mmol/L)
IFG	6.1-6.9		NA
IFG (isolated)	6.1-6.9	and	<7.8
IGT (isolated)	<6.1	and	7.8-11.0
IFG and IGT	6.1-6.9	and	7.8-11.0

OGTT = Oral glucose tolerance test
NA = Not applicable

2. *Diabetes Prevention* refers to reducing the incidence of new cases of T2D over a three- to 20-year period.
3. *Program Efficacy* refers to how successful diabetes intervention programs are at decreasing incident cases of diabetes [21].
4. *Ecological approach* refers to a model of understanding health behavior that proposes an interaction between intrapersonal, sociocultural, environmental and policy factors [31-32].
5. *Precede-Proceed model* is a program planning model with two components. The Precede component consists of a “series of planned assessments that generate information able to guide subsequent decisions” [21]. Precede is an acronym for *p*redisposing, *r*einforcing and

*e*nabling constructs in *e*ducational/*e*cological *d*iagnosis and *e*valuation. The Proceed component is the “strategic implementation of multiple actions based on what was learned from the assessments in the Precede component” [21]. Proceed is an acronym for *p*olicy, *r*egulatory and *o*rganizational *c*onstructs in *e*ducation and *e*nvironmental *d*evelopment. The Precede phase identifies goals and targets that are then implemented in the Proceed phase.

6. *Grounded Theory* as described by Strauss and Corbin [33] is “a theory that is derived from data, systematically gathered and analyzed through the research process. The researcher begins with an area of study and allows the theory to emerge from the data”.

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CHAPTER 2:

Literature Review

The Problem of Diabetes

Currently, it is estimated that 8% of adult Canadians are estimated to have diabetes [1], of which 90-95% are people with type 2 diabetes (T2D) [2]. In Canada, the World Health Organization is projecting a 57% rise in prevalence of diabetes by the year 2030 [3]. Increasing prevalence of T2D is related to higher incidence rates, increased obesity rates in the population, people with diabetes living longer, population growth of high-risk ethnic groups and an aging population [4-7]. Recent U.S. data reports that rising levels of obesity are strongly associated with increasing incidence rates of diabetes [4, 8]. For example, if a person's body mass index (BMI) exceeds 35 kg/m^2, they are 93 times more likely to develop T2D than someone who has a BMI of 21 kg/m^2 [9]. Additional factors that may contribute to increasing numbers of people diagnosed with T2D include new diagnostic criteria [4-5, 10] and improved diabetes detection through screening programs (although new cases are not younger or healthier which is the trend that would be expected if people were being diagnosed sooner) [4]. The increasing incidence and prevalence of T2D is associated with numerous social and personal costs.

When a man is diagnosed with T2D at the age of 40 he will lose 12 years of life and 19 years of quality-adjusted life and a woman will lose 14 years of life and 22 years of quality-adjusted life [11]. The loss of quality of life transfers into economic costs. For instance, the Canadian Diabetes Association has estimated the annual cost of diabetes in Canada at $9 billion USD [12] but this may be an underestimate [13]. In the U.S. direct and indirect costs of diabetes in 2002 were estimated to be approximately $132 billion USD [14]. A recent study by Simpson et al [13] estimated that approximately 15% of the total expenditures in Saskatchewan on hospitalizations, physician services and prescription drugs

resulted from a diabetes diagnosis. This is remarkable, considering only 3.6% of the population in Saskatchewan has been diagnosed with diabetes [13]. Thus, preventing or delaying T2D in high risk individuals, could represent significant benefits to the Canadian health care system as well as the individual [13, 15-17].

The Problem of Prediabetes

People at high risk of T2D include those who are over 45 years in age, are overweight, have a genetic predisposition (family history), have prediabetes, are physically inactive, are members of high-risk ethnic groups, have a history of gestational diabetes or birthing a baby greater than nine pounds, have cardiovascular risk factors (hypertensive, low LDL cholesterol or high triglyceride levels), have polycystic ovarian syndrome or have a history of vascular disease [18]. Of these risk factors for T2D, obesity, physical activity, cardiovascular risk factors and potentially prediabetes are modifiable. Prediabetes describes individuals who have impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) [7]. Impaired fasting glucose (IFG) is defined as a fasting plasma glucose between 6.1 and 6.9, and a 2-hour plasma glucose less than 7.8 after a 75 gram (g) oral glucose load [7]. Impaired glucose tolerance (IGT) is defined as a fasting plasma glucose greater than 6.1 mmol/L combined with a 2-hour plasma glucose between 7.8 and 11.0 mmol/L after a 75 g oral glucose load [7].

No Canadian data are available documenting the prevalence of prediabetes in the adult population; however large-scale screening projects have been conducted in Denmark, the United States and Australia [19-21]. The prevalence of prediabetes (using a 75 g oral glucose tolerance test and 2-hour plasma glucose in adults aged ≥ 45) in these countries ranged between approximately 15%-34% in Denmark, 25%-40% in the United States and 17%-30% in Australia [19-22]. Therefore, extrapolating from the 25%-40% prevalence

rate documented in the U.S. [19, 22-23], of the 1.2 million people aged ≥ 45 years in Alberta [24] potentially 300,000-480,000 of them could have prediabetes.

Practical Implications

The Canadian Diabetes Association has recommended that people diagnosed with prediabetes receive interventions that prevent the development of diabetes, and modify cardiovascular disease risk factors [7]. Without intervention, it is likely these individuals will develop T2D over time [25-26]. These new national guidelines on T2D prevention efforts in adults with prediabetes have been developed as a result of the documented efficacy of lifestyle-related behavior change interventions [7]. However, only limited numbers of adults with prediabetes are actively trying to decrease their development of T2D [23]. To date, there are limited Canadian data on effective and feasible strategies to prevent or delay T2D through obesity treatment and prevention, improved dietary intake and increased physical activity [7, 27-30].

Interventions for Prediabetes

A number of multi-center randomized controlled trials (RCT) have demonstrated a reduction in relative risk of developing T2D in those with prediabetes as a result of small changes in weight, diet and physical activity [31-34]. To date, the lifestyle interventions for adults with prediabetes demonstrating the highest level of efficacy promote a combination of physical activity (i.e., 150 minutes of moderate-intensity activity per week) and dietary (i.e., ≤ 25-30% calories from fat and ≥ 15g/1000 kcal of fibre) goals with the goal of reducing body weight by 5-7% [31, 34].

Da Qing IGT and diabetes study

The Da Qing IGT and diabetes study was an early lifestyle intervention program conducted in 33 local health clinics in Da Qing, China [33]. The Da Qing

study compared a diet, exercise and diet plus exercise group to an information-only control group over a 6-year period (N=530, 8% loss to follow-up). In the diet-only, exercise-only and diet and exercise groups there was a significant reduction in incidence of T2D diabetes compared to the control group (33%, 47% and 38% respectively). Therefore the lifestyle intervention was demonstrated to be effective at reducing the progression of IGT to T2D over the time period the study was conducted [33]. After a 20 year follow-up from the beginning of the trial in 1986, there was a 43% reduction in the risk of developing T2D in the combined intervention groups compared to the control group [26]; however in the intervention groups 80% of adults with prediabetes still developed T2D and 93% of the control group developed T2D [26]. Compared to the control group, those in the intervention group delayed T2D development by 3.6 years [26].

The lifestyle intervention in the Da Qing study [33] involved the diet-only and exercise-only group receiving 1) individualized dietary or exercise prescriptions from physicians, and 2) small group counseling sessions one time per week for one month, one time per month for three months and then once every three months for the duration of the study period. The diet plus exercise group received the same counseling protocol but were given individual diet and exercise counseling. The goals for dietary intake included 25-30 kilocalories (kcal)/kg body weight, 55-65% of kcal from carbohydrate, 10-15% from protein and 25-30% from fat. Participants were counseled to eat more vegetables, control intake of alcohol and reduce intake of simple sugars. Weight loss goals included a reduction of 0.5-1.0 kg per week until a BMI of 23 kg/m^2 was achieved. The exercise goal included an increase of 30 minutes of mild activity, 20 minutes of moderate, 10 minutes of strenuous or 5 minutes of very strenuous physical

activity one to two times per day. The control group received information only and did not attend any group counseling sessions.

At baseline and 6-year follow-up there were no statistically significant differences in dietary intake between the intervention groups. At baseline the diet plus exercise group were significantly more active than the other 3 groups; however at the 6-year follow-up both exercise groups had significantly increased time spent in physical activity compared to baseline [33]. Weight loss ranged from 0.7 kg to 3.3 kg in the intervention groups and was highest in the diet plus exercise group.

The Finnish Diabetes Prevention Study

The next randomized controlled trial to report positive effects of lifestyle intervention was The Finnish Diabetes Prevention Study (DPS) [31]. The DPS (N=434, 17% loss to follow-up) compared an information-only control to an intervention group that included an intensive diet and exercise program [35]. The intervention group demonstrated a 58% reduction in T2D incidence after three years compared to the control group [31]. The lifestyle intervention goals of the DPS included a) reduction of at least 5% of body weight (0.5-1 kg/week), b) increasing moderate-intensity physical activity to greater than 30 minutes a day, and c) consuming a lower fat and higher fibre diet (<30% kcal from total fat, < 10% calories from saturated fat, and > 15 g/1000 kcal of fibre.

The intervention group in the DPS attended an annual physician visit and individualized counseling with a dietitian at week zero, week one to two, week five to six and months three, four, six and nine, then every three months after for three years. Topics discussed were focused on the dietary and exercise goals of the program but individualized recommendations were made based on results from three-day food records completed by participants. In addition, voluntary

group sessions were offered on different nutrition and exercise related topics such as low-fat cooking, grocery store tours, and group walking and hiking sessions. For the exercise intervention, endurance activity was recommended and moderate-intensity circuit-training sessions were offered at no cost. Between visits, dietitians phoned participants and sent letters as follow-up. After six months if the weight loss goals were not being met, a very-low kcal diet was prescribed for two to five weeks to increase weight loss. The education program for the control group included one group education session for 30 to 60 minutes and some printed materials [31].

The mean weight change in the intervention group was about 3.5 ± 5.1 kg at three years compared to a loss of 0.9 ± 5.4 kg in the control group ($p < 0.001$). In the intervention group, 45% of participants met their weight change goal compared to 14% in the control group. While total leisure-time physical activity remained unchanged, moderate leisure-time physical activity increased to 61 minutes per week (-33 to 168) in the intervention group compared to only six minutes (-91 to 104) in the control group. The dietary goals of the study were generally not met, although greater improvements were demonstrated in the intervention group (37%, 21% and 37% of intervention group met the total fat, saturated fat and fibre goals respectively compared to only 20%, 9%, and 23% of the control group). Waist circumference was significantly decreased in the intervention group by a mean of 3.3 ± 5.7 cm compared to 1.2 ± 5.9 cm in the control group ($p < 0.001$). In addition, glycosylated haemoglobin and serum total cholesterol to HDL ratio decreased. Fasting blood glucose and 2-hour plasma glucose remained unchanged between the groups.

In the intervention group over the three year time frame, 9% developed diabetes compared to 20% of the control group [31]. After the intervention period,

those in both groups were followed for a median of three years and saw a nurse yearly to discuss the progression of their disease; however no specific diet or physical activity counseling was given during this time [25]. Over the intervention and follow-up period, there was a 43% reduction in relative risk of developing T2D in the intervention compared to the control group [25].

The American Diabetes Prevention Program

The American Diabetes Prevention Program (DPP) was a multi-center RCT conducted across 27 centers in the U.S [34]. The DPP (N=3234, 8% loss to follow-up) compared three groups: standardized lifestyle recommendation plus Metformin (850 mg twice daily), standardized lifestyle recommendation plus placebo and an intensive lifestyle modification group. After approximately three years the intensive lifestyle intervention group demonstrated a 58% reduction in T2D incidence (same as Finnish DPS) compared to the control group. In the Metformin group there was a 31% risk reduction compared to the control group and in those with a BMI over 35 kg/m^2, the risk reduction was approximately 50% [34]. The intensive lifestyle intervention goals of the DPP included a) reduction of at least 7% of body weight (0.5-1 kg per week) in the first six months, b) increasing moderate-intensity physical activity to at least 150 minutes per week, and c) dietary modification to a lower-fat and kcal diet (500-1000 less kcal/day) [36].

The intensive lifestyle group participated in the “Lifestyle Balance” intervention. This program was provided by individual case managers who were either dietitians or had Masters’ degrees in exercise physiology, behavioral psychology or health education. This core intervention included individual sessions, group classes, and motivational campaigns depending on the site where the program was offered. The standardized intervention included 16-

sessions that participants were required to attend over a 24-week period. These sessions ranged from 30 to 60 minutes and included a private weigh-in, review of self-monitoring records, group presentation, discussion of personal barriers to weight loss and a goal-setting activity. Topics that were discussed included self-monitoring of weight, dietary modification to a lower-fat and kcal diet, and self-monitoring of fat, calories and physical activity. The clinic sites were also required to provide a supervised physical activity session at least two times weekly throughout the study period. The maintenance program required face-to-face contact every two months and telephone follow-up at least once between visits for the duration of the study period. The case managers were also able to book additional individual follow-up and provide varying services or strategies as needed. During the maintenance phase, participants were encouraged to self-monitor their intake and physical activity one week per month. Each clinic site was also required to offer three group sessions per year during the maintenance period. One session per year was taught on motivation, one on physical activity and one on healthy eating or weight loss. The standardized lifestyle recommendations for the Metformin and placebo groups included written information and a yearly 20 to 30 minute individual session that encouraged participants to follow a diet to reduce cardiovascular risk factors, reduce weight and increase physical activity. The intensive lifestyle intervention was not standardized across clinic sites as the study was not designed to provide data on what intervention would be considered best practice within community settings [36].

In the intensive lifestyle intervention group 38% of participants achieved a 7% weight loss at their last follow-up appointment [34]. The average weight loss in the placebo, Metformin and lifestyle-intervention groups was 0.1, 2.1 and 5.6

kg respectively. Approximately 58% in the intensive lifestyle group were physically active for at least 150 minutes per week and increased their MET-hours/wk by about 5.8. This was significantly different than both the Metformin and control groups who only increased their MET-hours/wk by approximately 0.5-1 ($p<0.001$). Daily energy intake at year one was reduced from baseline by 450 ± 26 kcal in the intensive lifestyle group compared to a decrease of 249 ±27 kcal in the placebo group and 296 ± 23 kcal in the Metformin group. Fasting plasma glucose was similar between the Metformin and the intensive lifestyle groups and decreased during the first year and then increased almost to baseline levels by the third year. Within the placebo group, fasting plasma glucose rose steadily from the baseline measurement. A similar pattern was demonstrated by glycosylated haemoglobin measurements.

In the intensive-lifestyle group over the three year time frame 14.4% of people developed diabetes compared to 21.7% in the Metformin group and 28.9% in the placebo group [34]. After a 10 year follow-up from study initiation, T2D incidence was reduced by 34% in the lifestyle intervention group and 18% in the Metformin group compared to the control group [37]; however, the control and Metformin group were able to attend the 16-week intensive lifestyle intervention sessions after the efficacy trial was completed. This may have resulted in a reduced incidence in these two groups that is higher than if they did not receive any of the lifestyle intervention [37].

The Indian Diabetes Prevention Programme

The Indian Diabetes Prevention Programme (IDPP-1) is a recent randomised community-based study conducted in India [32]. This study (N=502, 5% loss to follow-up) compared four groups, a control group, lifestyle intervention group, Metformin group + lifestyle and Metformin group over a three year period.

Each of the treatment groups saw a reduction in the relative-risk of T2D compared to the control group (lifestyle: 28.5%, Metformin: 26.4%, and lifestyle + Metformin: 28.2%). The goals of the intervention program included a) increase or maintain moderate-intensity physical activity for at least 30 minutes per day, and b) dietary modification by reducing total kcal, refined carbohydrate, and fats as well as avoidance of sugar and increased consumption of foods high in fibre [32]. The IDPP-1 did not include a specific weight loss goal while the other three studies exploring T2D prevention in those with prediabetes did include weight loss as a goal [31, 33-34].

The lifestyle intervention was provided at baseline by telephone or letter, at two weeks, and then by monthly telephone contact [32]. Individualized sessions were conducted every six months over the study period. The control group was given standard health care advice only.

The proportion of people meeting the physical activity goal of 30 minutes per day increased by about 15% in the lifestyle and lifestyle + Metformin group. Diet adherence also improved from baseline by approximately 20% in both the lifestyle and lifestyle + Metformin group. There was a significant increase in weight in the control group at all time points and the lifestyle modification group at 24 months. This weight increase however was less than one kilogram in all groups. There were no significant changes from baseline in waist circumference at the 30-36 month time point in all four groups.

While this study supports the reduction in T2D risk demonstrated in the other three trials, there are a number of limitations within the study design. These limitations included limited information on the intervention techniques used, general goals for diet, no validity or reliability information on the measures used

to collect physical activity and dietary information as well as no statistical comparisons between the groups reported for specific behaviors.

Summary of Diabetes Prevention Studies

The main finding of the diabetes prevention trials was that very small changes in behavior and clinical outcomes corresponded to a significant reduction in the risk of developing T2D among people with prediabetes [31-34]. In addition, over the long-term these studies demonstrate a 34%-43% risk reduction for T2D in the lifestyle intervention groups [25-26, 37].

To date, T2D prevention studies have included primarily three targets for behavior change: weight loss, changes in physical activity and changes in dietary intake. A secondary study from the DPP examined the contributions in the intensive lifestyle group from each behavior individually and the impact physical activity and dietary change had on weight loss to reduce T2D incidence [27]. In the multivariate model weight loss was the strongest predictor of reduced T2D incidence (HR per 5 kg weight loss=0.42, 95% CI = 0.35-0.50). Increasing physical activity and lower percent calories from fat did not have any significant direct effect when measured as continuous variables. Weight loss predicted a lower incidence of T2D across all ethnic groups, genders, ages and activity levels and was not affected by baseline weight status. When examining people who met the established DPP goals with those who did not meet the goals, those who met their weight, exercise and fat intake goals were 89% less likely to develop T2D than those who did not meet any goal and exhibited only a small weight loss (-1.5 kg) [27]. Those who met the physical activity goal of 150 moderate-intensity minutes/week had a reduction in T2D incidence of approximately 44%, even after adjustment for weight change, indicating that meeting the physical activity goal may have been an independent predictor of reduced T2D incidence. Predictors of

short and long-term weight loss included lower percent fat intake, and increased physical activity [27]. These researchers concluded that people who lose over 7% of their body weight, who are moderately active for a minimum of 150 minutes a week, and who consume less calories from fat could reduce their risk of developing T2D by greater than 90% [27].

Macronutrient intake was measured in both the DPP and the DPS to determine the relationship between fat and fibre intake and weight loss. The DPP used a food frequency questionnaire to collect diet information at baseline and year one; however no dietary information was collected after year one [34]. The Finnish DPS examined the relationship between dietary intake and changes in weight status and waist circumference over the entire three year study period [38]. Dietary intake was collected using three-day food records that were verified by a dietitian [38]. This method of dietary data collection is considered preferable to the use of a food frequency questionnaire (i.e., collection technique used in the DPP) as it has a greater degree of validity [39]. In the DPS, a significant relationship was identified as people who lost more weight were also more likely to eat less fat and more fibre. After adjusting for demographics, weight change, physical activity and baseline glucose, eating a diet high in fibre compared to low in fibre reduced incidence of T2D by 62% (HR=0.38, 95% CI=0.19-0.77). Those who ate a high-fat versus low-fat diet were two times more likely to develop T2D (HR=2.14, 95% CI=1.16-3.92) and those who ate a diet high in saturated fat were also more likely to develop T2D after four years (HR=1.73, 95% CI= 0.89-3.38). These researchers concluded that fat and fibre intake were significantly related to weight loss and maintenance of weight loss over time in people at high-risk of developing T2D [38].

A recent position statement from the American Diabetes Association concludes that prediabetes treatment should include a reduced calorie and fat diet to achieve weight loss in those with prediabetes [40]. In addition, fibre intake should be at least 14 g/1000 kcal as advised by the Dietary Reference Intakes [41]. While incorporating high-fibre foods such as fruits and vegetables has been associated with reduced T2D risk [42-43], there is still insufficient evidence to recommend a low-glycemic index diet to prevent T2D [40]. Weight loss appears to be a key factor for the prevention of T2D [44]. A recent review of long-term interventions to prevent weight gain reported restricting calories and encouraging a low-fat diet with and without meal replacements was significantly associated with weight loss in adults; however a Mediterranean diet had greater success compared to a low-fat diet [45]. The use of meal replacements appeared to increase the amount of weight loss, especially over the long term [45]. The addition of exercise to interventions promoting dietary restriction did not appear to enhance long-term weight loss [45]; however in a study using only a low-fat diet without exercise, small amounts of weight loss did not appear to lower T2D risk in postmenopausal women as demonstrated in other T2D prevention trials [44]. In summary, current public health recommendations promoting healthy eating and physical activity are also appropriate for those with prediabetes wishing to decrease their risk of T2D, as long as weight loss is achieved [46-47].

Does Preventing or Delaying Diabetes Promote Cost-Savings?

The first cost evaluation of the DPP found that the intensive lifestyle intervention demonstrated greater cost-savings overall than treatment with only Metformin [15]. A more recent study assessed whether the intensive lifestyle intervention used in the DPP or treatment with Metformin would transfer into long-term cost savings in 5 different countries (Australia, France, Germany,

Switzerland, and the United Kingdom) [16]. The model simulated people with prediabetes who progressed to T2D at different rates depending on whether they received intensive lifestyle intervention, Metformin or standard lifestyle advice. In every country except the United Kingdom, there was a cost reduction associated with the intensive lifestyle program or treatment with Metformin compared to the standard lifestyle advice group. Among more obese people (BMI>30kg/m^2) Metformin had higher cost savings than intensive lifestyle therapy while among older and less obese people (22-30 kg/m^2) the intensive lifestyle intervention demonstrated a higher costs savings than Metformin [16].

A recent critique of the cost-effectiveness of the DPP suggests that the lifestyle intervention costs more per quality-adjusted life year than previously estimated and that an intervention program that uses the exact same methods would not be cost-effective for the healthcare system to offer [48]. This critique estimated that the annual cost of the DPP intervention (including personnel, health education materials, medications and laboratory tests) would need to be decreased from $672 to $100 per person per year (in 2002 USD) to be cost-effective over a 30-year period [48]. DPP researchers also recognize that a reduction in costs would be preferable and suggest achieving this by offering small group sessions versus individualized appointments (less than 10 people) to reduce the costs of staff time but not compromise the effectiveness of the intervention [49]. In summary, there is a need to identify lifestyle intervention programs that promote at least a 5-10% weight loss and are less expensive than research trials such as the DPP.

To increase cost-effectiveness, health care systems need to identify methods to increase the proportion of individuals who are able to lose weight, while decreasing the program administration costs seen in the DPP. More

research is needed to identify methods that increase change but decrease costs associated with intensive lifestyle intervention. For example, in the American DPP only 17% of individuals in the intensive lifestyle intervention group were able to meet weight loss, diet and physical activity goals [27]. In the Finnish DPS only 45% of the intervention group lost 5% of their body weight; most of the intervention group did not get 150 minutes per week of physical activity and only 37% ate less than 30% of their calories from fat [50]. Thus, identifying interventions which incorporate cost-effective strategies (e.g. group counseling) that successfully facilitate behavior change, and are applicable within a healthcare setting, should be a primary research priority in T2D prevention.

Chronic Care Model for Chronic Disease

The Chronic Care Model (CCM) was developed in response to the demand for improvements in care for chronic conditions [51]. The original CCM was developed in the United States based on a literature review and consultation with experts in healthcare delivery [52]. The CCM includes six main components that impact how productive the interaction is between the health care team and the patient [53]. These include: the health system, delivery system design, decision support, clinical information systems, self-management support and community resources and policies. An expanded CCM has been proposed in order to integrate a Canadian population health approach [54]. The expanded CCM includes the original components of the CCM and adds the following components: building healthy public policy, creating supportive environments, strengthen community action, develop personal skills, and re-orient health services [54]. A description of each component of the CCM and the expanded CCM is necessary to understand how the model applies to a health care system.

The purpose of the *health system*, the first component, is to provide an organizational culture that promotes safe, high quality care. This is directed by senior leadership and encourages program planning that incorporates improvement goal-setting, change, and evaluation [54-55]. Support and direction from senior leadership facilitates the use of the other CCM components [56]. The second component, *design of the delivery system,* targets clinical care and self-management support to ensure effective and efficient delivery [55]. This could include regular client follow-up by the health care team, provision of culturally relevant care, use of clinical practice guidelines, having clear delineations between team members' positions and including group management of complex patients [55]. The expanded CCM adds *re-orienting health services* to design of the delivery system [54]. *Re-orienting health services* encourages health professionals to advocate for improved health for individuals and communities beyond solely providing clinical services. This includes health professionals advocating for healthy public policies and environments [54]. The third component of the CCM is d*ecision support* and this refers to how the health system provides clinical care and health promotion strategies that are consistent with scientific evidence, and health professional and patient preferences [54-55]. For example, organizations could provide in-service opportunities for staff to stay up-to-date on new evidence for treatment or health promotion programs that have been successfully offered at other sites. In order to organize patient and population data *clinical information systems*, the fourth component, should be implemented [55]. This system tracks patients to provide relevant data to practitioners and provide reminders for follow-up. In health promotion it can also be used to provide information on demographics, health-related behaviors, and health, social and economic trends [54]. The fifth component of the CCM, s*elf-*

management support includes *developing personal skills* from the expanded CCM. The purpose of these components are to empower patients to manage their health and promote health and wellness through skill development and behavior change [54-55].

Lastly, the CCM discusses the importance of developing partnerships with *community* organizations to support and meet patients' needs. The expanded CCM adds three components under the community umbrella*: building health public policy, creating supportive environments* and *strengthening community action. Building healthy public policy* relates to the importance of promoting policies and legislation that promote health in community environments, the workplace, and the goods and services industry [54]; for example, passing laws that prohibit smoking in public places. *Creating supportive environments* includes promoting health through optimal living and working conditions [54]; for example, providing work-out facilities and paid times to exercise within the work place. *Strengthening community action* involves supporting community groups to help them promote health in their communities [54]. For example, a community health worker partnering with a parent council to plan a walking school bus program to transport children safely to and from school and promote physical activity.

Support for CCM

A recent review [57] examined the success of four components of the CCM in diabetes management ambulatory interventions; these components were similar to those used in diabetes prevention studies: self-management support, decision support (educational materials and meetings for physicians), delivery system design (use of case managers, multidisciplinary teams and scheduled follow-up), and clinical information systems (reminders and feedback of physician

performance). Of the 39 studies that included at least one component of the CCM, 32 of these studies had improvement in at least one process or outcome measure. Studies that included more than one component were not found to be any more effective than those that only included one, although 19 out of the 20 studies that included self-management support improved outcomes (e.g., enhancing skills of participants). The DPS and DPP diabetes prevention programs both focused on enhancing self-management support.

Other studies have also examined the use of the CCM in diabetes management [58-60]. Nutting et al. (2007) examined components of the CCM and their relationship to improvements in HbA_{1C} and lipid levels of people with diabetes. Questionnaires were distributed to 90 clinicians and assessed various components of the CCM. These components included: use of a registry and tracking system for tracking and reminding patients between visits (clinical information systems); follow-up of patients with telephone calls, and using office staff to remind patients of follow-up or need for other services (practice design); use of clinical practice guidelines, referral of patients to outside source for diabetes education, and use of flow sheets to track care (decision support); and, using goal-setting, and referrals to someone within the practice for support (self-management support). For each unit increase in components of the CCM (e.g., from rarely to occasionally), there was a decrease in HbA_{1C} of 0.30 and total cholesterol to HDL ratio of 0.17. Thus, components of the CCM were found to improve clinical outcomes in people with diabetes.

Vargas et al. (2007) examined 10-year cardiovascular disease (CVD) risk in people with diabetes in CCM-based healthcare organizations (n=613) compared to organizations not using the CCM (n=557). This study was novel as all components of the CCM were implemented. The implementation of the CCM

had modest significant improvements on 10-year CVD risk of 2.1% or prevented 1 CVD event in every 48 people. In a randomized controlled trial examining the effectiveness of a CCM-based diabetes care intervention [58], reductions in HbA_{1C} were observed in the CCM group (n=30) but not the education only group (n=38), or the usual care group (n=51). The CCM group also had significant improvements in HDL cholesterol, self-monitoring, diabetes knowledge and levels of empowerment. This was a small pilot study but demonstrates that implementation of the CCM is feasible and can effectively enhance diabetes management services.

There are some documented barriers to implementing the CCM [56, 61-62]. The model has been found difficult to implement and, as a result, some components are not widely used [56, 62]. For example, in the case of diabetes management, nine surveyed medical practices reported use of clinical practice guidelines, population disease management strategies and took part in health promoting activities but only 44% used case management strategies [56]. In addition, medical practices did not consistently use technology to track patients, correspond with patients and provide reminders for follow-up [56]. Other reported barriers to successful implementation of CCM components include lack of financial incentives for the improvement of health care, lack of financial and staff resources, lack of adequate clinical information systems, heavy workloads, providers are not paid more for providing higher quality care, and doctors resisting changes within their practices [56, 62].

Limitations of CCM

There are some additional limitations to incorporating components from the CCM. It is unknown if it is necessary to incorporate all components of the CCM to see improvements in care and cost-savings [57]. In a Canadian health

care context with limited resources, it is important to determine what components can be incorporated in an acceptable way and incorporate components that are seen as a priority. In addition, the CCM provides some research-based guidelines for delivery of a health care system but does not provide specific program ideas that are tailored to a target population at a certain place and time. Before implementing CCM components in a particular service area, such as T2D prevention, the service area needs to be evaluated to determine what steps are necessary to improve the provided service. T2D prevention programs will likely be more successful if they are based on what is acceptable and desired from the involved health professionals and people with prediabetes [63].

The CCM provides a general guiding framework organizations can use in developing their health care system but it does not give specific methods, tailored to individual systems to improve outcomes. More research is needed to determine what components of the expanded CCM model will be successful within T2D prevention services. The proposed research studies are a critical step to help identify these CCM components, specific to a T2D prevention context.

Theory-Based Research Using the Precede-Proceed Model

T2D prevention programs have used multiple intervention strategies to facilitate behavior change. These programs were designed to determine the efficacy of T2D prevention, not to identify intervention strategies that would be translatable to multiple communities [36]. More research is needed to determine what intervention strategies would be appropriate for use in community settings [36].

When designing an intervention, a program planning model provides structure and guidance on how to identify optimal intervention strategies [64]. Program planning models assess several levels of influence (i.e. individual,

family, community, sector/system, and society) and multiple factors (intrapersonal, sociocultural, policies and physical environments) that impact both volitional and operant behaviors. When different levels of influence and factors are targeted, sustained behavior change is more likely [65-66]. However, the majority of research in T2D prevention has targeted individuals without considering the impact of health behavior theory or the contextual, social, community, cultural or environmental influences on behavior [67]. Therefore, using a program planning model to guide the assessment of different levels of influence and factors that impact behavior should result in the development of a lifestyle intervention program that potentially increases behavior change without increasing program costs.

One program planning model that assesses multiple influences and factors is the Precede-Proceed model [63]. The Precede-Proceed model (see Figure 2.1) begins with the proposed goals of a program and works backwards to define the activities that are necessary to accomplish these goals [63]. It provides a blueprint that enables program planners to design an intervention that is based on the actual needs and wants of the target population [64]. There are four assessment phases within the Precede portion of the Precede-Proceed model that help decision makers identify appropriate strategies they can implement in specific health care contexts [63]. The information gathered in the assessment portion of the model guides the researcher or program planner on what direction the intervention program should take. It also provides the researcher with a road map for identifying relevant research questions and generating hypotheses. The four assessment phases within the Precede portion include social assessment, epidemiological assessment, educational and ecological assessment and an administrative and policy assessment. Further explanation of each phase, a

summary of current T2D prevention research within each phase, and gaps in the T2D prevention literature are identified below.

Phase One: Social Assessment

The first phase within the Precede-Proceed model is social assessment. When conducting a social assessment, quality of life concerns and social concerns of the target population (publics' perceived needs, health professionals' perceived needs and policy makers perceptions) are identified [63]. Traditionally within the Precede-Proceed model, a program planner would gather information from the target population about what quality of life or social concerns they have and use the identified concerns as targets for intervention. One limitation to designing a T2D prevention program, using the Precede-Proceed model, is the health-related goals of the target population are predetermined by what the research literature has identified as efficacious. Consequently, the target population has not been directly involved in identifying the primary goals of T2D prevention programs (i.e., weight loss, increased physical activity, dietary change). They can be involved however by providing information on their perceptions of how to increase the success of meeting these goals. The social assessment phase raises research questions such as: *How do adults with prediabetes rate their quality of life and what are some possible influences? How do health practitioners and people with prediabetes describe their role in the process of behavior change and motivation? What type of T2D prevention program do policy makers feel is feasible? What program format (e.g., internet, face-to-face, telephone counseling) do people with prediabetes feel is most motivating?* Gathering this type of data will inform theory development and potentially increase the success of a T2D prevention program [63, 68].

There is limited research on health-related quality of life in people with prediabetes [69]. One example compared self-reported quality of life of those with normal glucose tolerance to those with prediabetes and those diagnosed with T2D using the SF-36 Quality of Life Scale [70]. The SF-36 is a self-administered general health quality of life measure that scores people on eight domains including: bodily pain, general health perception, mental health, physical functioning, impairment to role due to emotional problems, impairment to role due to physical problems, social functioning and vitality [70]. For each of these eight domains there were decreases in mean quality of life scores from normal glucose tolerance, prediabetes, to diagnosed T2D [70]. Those with IGT were 44% and 46% more likely to report complications with physical and social functioning respectively while those with IFG had no statistically significant differences from those with normal glucose tolerance. Physical functioning is the person's self-rated ability to perform activities such as walking, climbing stairs, bending and stretching, lifting and carrying objects. Social functioning describes whether a person's physical or emotional health has interfered with their social activities [70].

This study by Tapp et al. [70] supports the importance of measuring quality of life in those with prediabetes prior to offering a T2D prevention program. Further research is needed among those with prediabetes to assess health-related quality of life and its relationship to physical activity; as increased physical activity is one of the main goals in T2D prevention programs. As well, social concerns (e.g., perceived needs and perceptions) of all key stakeholders, including policy makers, need to be assessed. These data will inform the development of a T2D prevention program.

Phase Two: Epidemiological Assessment

The second phase within the Precede-Proceed model is performing an epidemiological assessment. Within this phase, determinants of behaviors (e.g., poor diet vs. healthy diet, low physical activity vs. high physical activity) are examined prior to developing the program [71]. For T2D prevention this would include determinants of physical activity, and fat and fibre intake. Determinants of behavior may include participant demographics (e.g., age, gender, cultural background); health characteristics (e.g., how long the person has had the chronic disease, body mass index, presence of comorbidities); ability of the target population to access health services they would prefer, and; behavioral characteristics including social support networks, cognitive determinants of behavior and actual personal health practices and coping skills related to the established program goals [63, 72].

Influence of Demographics

Age, income, gender, education level, cultural background and employment all potentially influence physical activity, dietary intake and weight [7, 73-75]. For example, in the DPP demographic factors such as female gender were related to lower physical activity levels, however age, race/ethnicity, income and education levels were not correlated with leisure-time physical activity [76]. In another study examining health and socio-demographic influences on physical activity in those with T2D, it was found that higher levels of physical activity were significantly associated with being male, a higher income and higher education level [77].

A study in Edmonton, Alberta examining physical activity and fruit and vegetable intake reported a number of relationships between demographic factors and these behaviors. Women, people who were unemployed, had a

higher education level, worked in a professional “white collar” position and older adults (50 years and older) were less likely to be physically active [78]. For fruit and vegetable intake, men who worked in trades or technical positions, those who were unemployed and people with less than a high school education were less likely to eat sufficient quantities of fruits and vegetables [79].

Another possible influence on behavior is cultural heritage or ethnicity. Certain ethnic groups have a high genetic predisposition to develop T2D [7]. Members of high-risk ethnic groups include people of Aboriginal descent, Hispanic, Asian, South Asian, and African descent [7]. These groups may also have different cultural practices that impact the behaviors targeted within T2D prevention programs.

Prior to implementation, T2D prevention programs should assess key demographic variables to define their influence on targeted behavioral outcomes and to determine if they are reaching a representative population. This will enable the program to be tailored to certain populations; such as incorporating methods to increase physical activity that are more successful in women or including foods from a traditional Aboriginal diet. It will also allow program planners to target specific high-risk groups to increase participation.

Health Characteristics

Certain health characteristics of adults with prediabetes may influence program planning. For example, participants who smoke are more likely to have a higher level of central obesity than nonsmokers with the same BMI [80]. If a large number of people in a prediabetes program were smokers then it would be advised to include a smoking cessation component within the prediabetes program. Alternatively, if there were very few smokers, as found in the Finnish

DPS, then offering a smoking cessation program would not be a wise use of limited resources [38].

Another health characteristic that is often correlated with physical activity is BMI. In the DPP, higher baseline BMI was correlated with lower physical activity levels [76]. In those with T2D, a lower body mass index and lower levels of perceived physical disability were associated with higher levels of physical activity [77]. In a recent survey of adults in Alberta, almost 34% were overweight (BMI=25-29.9) and 15% were obese (BMI≥30). Males were more likely to be overweight or obese as were older adults, people with less than a high school education, former smokers, people living in houses with incomes higher than $100,000 per year, and married people [81]. Health characteristics such as these need to be measured in those with prediabetes and their relationships to physical activity, weight loss and fat and fibre intake need to be determined.

Access to Health Services

Access to T2D prevention programs is important as people with prediabetes who do not receive treatment are much more likely to develop T2D over time [25]. Access is defined as "the ability to access health services that can be used to maintain and promote health, prevent disease and improve function to contribute to overall health" [72]. Many Canadians report having adequate access to primary healthcare services. For example, approximately 87% of women and 73% of men report at least one yearly visit to a physician [82]. Data are not available on whether those with prediabetes have access to T2D prevention services; however many people at a population level do access physicians regularly. These data suggest that access to T2D prevention services within the healthcare system needs to involve physicians who are aware of screening guidelines for prediabetes and T2D. Also, it raises the research

question of: *How do people who do not regularly see a physician know if they are at high-risk for development of T2D and how do they access T2D prevention programs?* Future research needs to examine if physicians regularly refer to established diabetes prevention programs and then explore the reasons referrals are made or not made.

Behavioral Factors

Behavioral factors refer to the lifestyle choices of individuals and groups that affect health behaviors (i.e., weight loss, physical activity, eating a low-fat, high-fibre diet) [63]. They also include the actual behaviors and actions of those surrounding the person, for example the behavior of co-workers, friends and family [63]. Others' actions and behaviors potentially influence the individual's with prediabetes ability to change their personal health behaviors; therefore it is important to examine these behaviors in the communities in which people with prediabetes live.

A recent population health survey in Edmonton, Alberta, provided detailed statistics on physical activity [78] and dietary behaviors [79]. This report identified that 60% of those, 18 years and older, were insufficiently active to achieve a health benefit. The most preferred physical activities included walking (48%), bicycling (18%), jogging/running (14%), swimming (13%), and weight training (13%) [78]. A recent survey of Canadians with T2D reported only 23.1% were considered active [83]; which as identified above is much lower than their surrounding community. Fruit and vegetable consumption was assessed using questions from the Canadian Community Health Survey 2000/2001 and 2003. Approximately 57% of people in the general population, 18 years and older, did not eat five servings of fruit and vegetables as recommended by Canada's Food Guide to Healthy Eating [79].

These data highlight the behaviors of the members of the community surrounding those with prediabetes. These data also highlight individuals who may be at higher risk for prediabetes and might benefit from screening interventions. It is unknown if people with prediabetes who received an intervention promoting healthy eating, increased physical activity and weight loss would have similar levels of physical activity and fruit and vegetable consumption. The available data does provide some parameters for research to examine in those with prediabetes. Before a T2D prevention program is implemented this data should be collected to determine current behaviors of the population and their potential influence on the behaviors of those with prediabetes.

Phase 3: Educational & Ecological Assessment

The education and ecological assessment phase of the Precede-Proceed Model includes three categories of factors that have the potential to influence behavior: predisposing factors, reinforcing factors and enabling factors. Predisposing factors interact with personality to provide motivation to perform specific behaviors [63]. Knowledge, attitudes, beliefs, and values of the target population are all predisposing factors [63]. For example, it has been demonstrated that dietary behaviors such as eating a low-fat diet can be directly influenced by a person's attitude towards eating a low-fat diet [84]. Predisposing factors alone are not able to predict behavior. For example, in Edmonton, Alberta, 95% of people have a positive belief that physical activity will keep them healthy, although only 40% are sufficiently active to obtain a health benefit [78].

Reinforcing factors follow a behavior and influence whether the behavior will occur again; examples of reinforcing factors include social support from influential others, and feedback from health care providers [63]. For example,

physical activity and dietary interventions are more likely to succeed if they are offered in a supportive group setting [85-86].

Enabling factors are the skills, environmental resources and barriers that influence behavior in the target population [63]. For example, interventions targeting physical activity and dietary behavior change are more effective when the interventions incorporate skills such as self-monitoring [66, 86] and goal-setting [66, 86] or when offered in a community setting [85].

Ecological settings are influences outside the individual that affect behavior, health, or quality of life and include both physical and social environments [63]. Social factors include the influence family and friends have on behavior, community norms, if health services are based in supportive communities, and current social policies that may promote or decrease targeted behaviors [67]. Physical environments include perceived and actual settings and how the individual interacts within settings [63, 66]. An example of how physical environments can influence PA is demonstrated in the association between higher amounts of walking and living closer to shops where a person can purchase things [87]. The impact different settings have on physical activity, weight loss and fat and fibre intake needs to be explored in adults with prediabetes to better design prediabetes programs.

Understanding the relationships between these factors and behavior may potentially result in the development of a program that promotes a greater degree of behavior change; however researchers have not evaluated many of these factors in a prediabetes population and additional research is needed in this area [88].

Understanding Predisposing, Reinforcing and Enabling Factors using Behavioral Theory

The Precede-Proceed model suggests using health behavioral theories such as the Transtheoretical model (TTM) [89], the Theory of Planned Behavior (TPB) [90], Health Belief Model [91], Protection Motivation Theory (PMT) [92], and Social Cognitive Theory (SCT) [93] to help define predisposing, reinforcing and enabling factors [63]. These behavioral theories are composed of measurable constructs (e.g., self-efficacy, social support) that provide researchers and practitioners a systematic framework in which to explain and predict health behaviors [94-95]. Furthermore, researchers have contended that theoretically-based programs may enhance the likelihood that individuals will successfully change their behavior [94]. Therefore, incorporating a theoretical approach based on behavioral theory into a T2D prevention program may increase the proportion of participants who successfully change their behavior [66, 86]. It is through the implementation of behavioral theories, and thorough analyses of the potential moderators/mediators of behavior change (i.e., theoretical constructs) that researchers and practitioners can begin to understand how to develop and implement theoretically based programs that maximize opportunities for behavior change [66].

Theoretical Evaluation

For a health behavior theory to be useful it has to be practical [96-98]. Practicality is determined by a theories ability to: a) have predictive utility, b) describe the relationships between key constructs, c) offer guidelines for assessment of the constructs within the theory, d) translate constructs into operational manipulations, and e) provide the basis for understanding why an intervention succeeded or failed [99]. Norman and Connor [97] applied these

criteria to the major health behavior theories and examined the evidence for each criterion.

For the first criterion, predictive utility, Norman and Conner [97] conclude that the TPB, SCT and PMT have adequate utility to be applied effectively to interventions whereas there is less evidence for the predictive utility of the HBM and TTM. Secondly, health behavior theories should describe the relationships between key constructs and describe how the model works together as a whole. This helps practitioners to be able to apply the theory within their program areas, which has been a reported difficulty in intervention research [95-96, 100]. For example, a review conducted by Anderson [95] identified that 88% of diabetes education programs are not theoretically-based. Again the TPB, SCT and PMT clearly outline these relationships where the HBM and TTM have been criticized for failing to adequately describe these links. SCT also has demonstrated its acceptability and usefulness to health practitioners [98]. Thirdly, a health behavior theory needs to describe how the key constructs should be measured or there is no consistency between studies. One common criticism of health behavior theories is behavioral constructs and theories have been inconsistently defined and measured in the literature [101-102] and have limited generalizability [103-104]. The TPB and the TTM have detailed measurement tools that have been widely used in research studies to measure the key constructs contained in those models; however both PMT and the HBM lack specific guidelines for measurement provided by these model's authors. The SCT has established tools for the key constructs but there are other constructs that are not routinely measured and the model has been criticized for lacking parsimony [105]. Bandura [106], has recently described a more parsimonious SCT model that can

be applied to health promotion programs which helps decrease confusion about the constructs to examine.

Fourthly, it should be possible to design intervention tools that will change key constructs to promote behavior change. Most health behavior theories are weak in this area with the exception of SCT. As a result, practitioners can find behavioral theories impractical for use in their setting and difficult to apply [107]. Therefore, actual methods to change theoretical constructs which then enhance behavior change must be examined, applied appropriately within the health behavior theories, and tested for their effectiveness. Bandura [108] proposes four different methods, with empirical support [109], to increase self-efficacy, a core construct from SCT. These include personal mastery (experiencing success in small progressive tasks, such as eating one more piece of fruit a week, then two more pieces a week, etc.), vicarious experience (seeing someone else successfully perform the behavior, such as a spouse eating more fruit), persuasive communications (reading a handout that convinces you change is important and helps you to make a change) and physiological feedback (losing weight or inches, seeing blood sugar or blood pressure decrease). Other methods with empirical support proposed to increase behavior change include using fear messages followed by an action plan on how to deal with the threat, and implementation intentions that describe when, where and how a new behavior is to be performed [97].

Finally, health behavior theories should provide an explanation for why an intervention failed or was successful. This is possible with all the health behavior theories if behavior change occurs and constructs change over the course of the intervention. Mediation analyses can then be applied to identify what constructs were responsible for behavior change [97].

To date, there are only a few examples of interventions that have measured moderators and mediators that facilitate health behavior change relevant to the prediabetes population. The DPP is the only diabetes prevention study to evaluate baseline moderators of physical activity behavior change at baseline, year one and the end of the study (2-3 years). However, this study did not evaluate moderators of dietary change or weight loss [76]. The potential moderators included stage of change for physical activity (i.e., precontemplation, comtemplation, preparation, action and maintenance), exercise self-efficacy, perceived stress, depression, and anxiety. A greater stage of change, higher exercise self-efficacy and lower perceived stress, depression, and anxiety scores correlated with higher levels of baseline, year one and end of study physical activity [76]. When entered into multivariate models lower levels of depression correlated with higher baseline physical activity, higher baseline exercise self-efficacy correlated with higher physical activity at year one and end of the study and a greater baseline stage of change was correlated with physical activity at the study end. While a variety of psychological constructs were measured, a limitation of this study is that no specific health behavior change theory was applied or measured. In addition, only baseline moderators were examined, so it is unknown if these constructs changed over the course of the intervention. Many behavioral theories hypothesize that it is the change over time in these constructs that mediate behavior change compared to the potential moderating effect of baseline variables [110-111].

A more recent study examined four health behavior change theories (i.e., TTM, TPB, SCT and Self Determination Theory (SDT)) and their ability to predict successful short-term weight loss [112]. This study included an intervention that targeted specific constructs from each theory and measured these constructs in

relation to physical activity and weight management at baseline and at the end of a 16-week program. In the multiple regression analysis, SCT predicted approximately 19.6% of weight change, TTM predicted 24.3% and TPB predicted 14.8%. Within SCT and TTM, weight management self-efficacy was responsible for most of the prediction of weight change. For exercise-related behavior change, exercise self-efficacy from the SCT was the strongest predictor, however importance/effort and intrinsic motivation towards exercise also demonstrated significant relationships with weight change. The authors concluded that the TTM and SCT explained more of the variance for weight change than the TPB or SDT and changes in the constructs related to weight management predicted more variance for weight change than the exercise-related models [112].

Further research is needed in those with prediabetes to examine predisposing, reinforcing and enabling factors. This will help to identify relevant theoretical constructs, determine the strength of relationship between these constructs and key behaviors (i.e., weight loss, physical activity and dietary intake), and provide acceptable guidance to practitioners on how to design successful theoretically-based interventions [76, 103, 113-114]. Constructs from SCT have been associated with physical activity, dietary intake and weight management and when incorporated into lifestyle interventions, behavior change has been demonstrated [66, 112, 115-118]. It appears that SCT meets the criteria for being a “practical” theory, is relevant to a prediabetes population as previous associations between SCT constructs and key behaviors have been demonstrated, and incorporates methods, that have empirical support, on how to influence SCT constructs within an intervention.

Overview of Social Cognitive Theory

Consistent with the Precede-Proceed model, SCT considers the interplay between the individual, their behavior and the environment (see Figure 2.2). This interaction is defined as “reciprocal determinism” [105]. Reciprocal determinism acknowledges that people are not just products of their environment but they also help create and control their environments [93]. The concept of reciprocal determinism makes SCT an ideal theory for study within the Precede-Proceed model as the Precede-Proceed model aims to describe how behavioral, environmental, and social factors influence and are influenced by health behavior [63].

SCT includes six core constructs suggested for consideration by health promotion researchers [106]. *Knowledge* of the risks and benefits of a health behavior need to be present before behavior can change (e.g., knowing that a person may be able to prevent T2D by losing weight if they have prediabetes). Knowledge is not enough to change behavior. People also need to believe they can produce the desired effect (e.g., weight loss) from the actions they are taking (e.g., kcal restriction). This is their *perceived self-efficacy*. This is the central tenet of SCT and influences all the other core determinants.

Outcome expectations include the expected costs and benefits of the health behavior. These include physical outcomes such as the enjoyable versus unenjoyable experience of the behavior (e.g., physical activity is fun versus physical activity is boring) and the material losses and gains (e.g., being physically active gives me more energy so I save time during the day versus being active takes too much time). Social outcomes are whether your interpersonal relationships are approving or disapproving of the new health behavior (e.g., a husband complains that his wife going for a walk takes time

away from their family). The third set of outcomes is how positively or negatively an individual evaluates themselves and their performance of the behavior. According to Bandura [106], Individuals want to do things that increase their self-worth and not do things that promote dissatisfaction with themselves (e.g., a person adding exercise to their daily life because they believe this helps them to be healthier).

Goals that people set for themselves fit into two categories, long- and short-term. SCT posits that short-term attainable goals with specific plans of action are more successful than long-term goals in changing behavior (e.g., a person who sets a goal of losing 50 pounds versus losing one pound a week by reducing their cheese intake).

The final core determinant of behavior includes *perceived facilitators and impediments* to behavior change. These include factors such as environmental influences, health care system structures, and personal and situational barriers (e.g. feel too tired/depressed/stressed to exercise) [106].

Phase 4: Administrative & Policy Assessment

In this phase of the Precede-Proceed model organizational structure is evaluated to determine if resources and policies are in place to ensure the success of the a T2D program [63]. Once efficacious program components are identified in the previous stages of the Precede-Proceed model, health professionals and managers need to have input into whether these program components would be feasible within the targeted organization or what changes would need to take place for these to become feasible. In addition, comparing the organization to the previously discussed expanded-CCM at this point may provide valuable insight to program developers. It is necessary when conducting community-based research to be mindful of organizational restrictions and to

effectively evaluate program ideas with key stakeholders throughout the development process [63, 65].

Research Studies

Evidence suggests that it is possible to prevent the progression of prediabetes to diabetes with small changes in body weight, physical activity levels and dietary intake. Diabetes prevention programs need to be developed that consider the specific characteristics of the target populations identified by health promotion/program planning models such as the Chronic Care model and the Precede-Proceed model, and when implemented are cost-effective and reach large numbers of individuals [119].

The research studies completed were designed to explore T2D service provision and provide a theoretical framework to guide development of an optimal T2D prevention program. An exploratory design using both qualitative and quantitative methodologies was used to identify a more comprehensive framework than would be identified if only one research methodology was used [120].

A qualitative study was completed using grounded theory methodology to gather data from people with prediabetes, health care professionals who provide services to people with prediabetes and policy makers within Edmonton, Alberta health region. The purpose of gathering qualitative data initially was to generate hypotheses to guide data collection in the survey, as there are few guiding theories specific to diabetes prevention programs [120]. The research questions in this study were:

Health professionals: 1) what health information is currently provided to clients diagnosed with prediabetes in Capital Health; 2) when is health information provided to clients diagnosed with prediabetes and what is the

referral process to the prediabetes education class; 3) what health care professionals should provide the majority of service to people with prediabetes; 4) what goals should be included in diabetes prevention programs and why or why not are these goals being met; 5) what barriers do health professionals perceive influence adults with prediabetes behavior change and prevent these adults from achieving lifestyle changes.

Adults with prediabetes: 1) the health information they had received; 2) the type of prediabetes services adults would consider optimal; and 3) the facilitators and barriers they felt impacted their lifestyle changes.

A cross-sectional survey was also distributed to a randomly-selected adult sample who had attended a prediabetes education class in Edmonton, Alberta. The objectives of this study were to:

1) Determine the proportion of adults with prediabetes who were meeting prediabetes PA recommendations and to determine if any differences in HRQoL existed between individuals with prediabetes who are insufficiently active compared to those who are sufficiently active.
2) Describe current dietary intake patterns and investigate fat and fibre intake, and PA in adults with prediabetes using the SCT framework.
3) Identify physical activity and program preferences in those with prediabetes and to determine the association between demographics, health characteristics and current PA status on these preferences.

Hypotheses

Given the exploratory nature of the qualitative study no hypotheses were generated. Hypotheses were generated for the objectives of the quantitative survey. 1) We hypothesized that individuals with prediabetes meeting PA guidelines would report higher HRQoL (i.e., physical and mental functioning) than

those not meeting PA guidelines. 2) We also hypothesized that self-efficacy for eating a low-fat and high-fibre diet would be significantly related to fat and fibre intake and that PA self-efficacy would be significantly related to leisure-time PA in adults with prediabetes. No hypotheses were generated for PA and program preferences due to the exploratory nature of that paper.

Figure 2.1 Precede-Proceed model [63]

This figure is a representation of the “main lines of causation from program inputs and determinants of health to outcomes by the direction of the arrows.” [63]

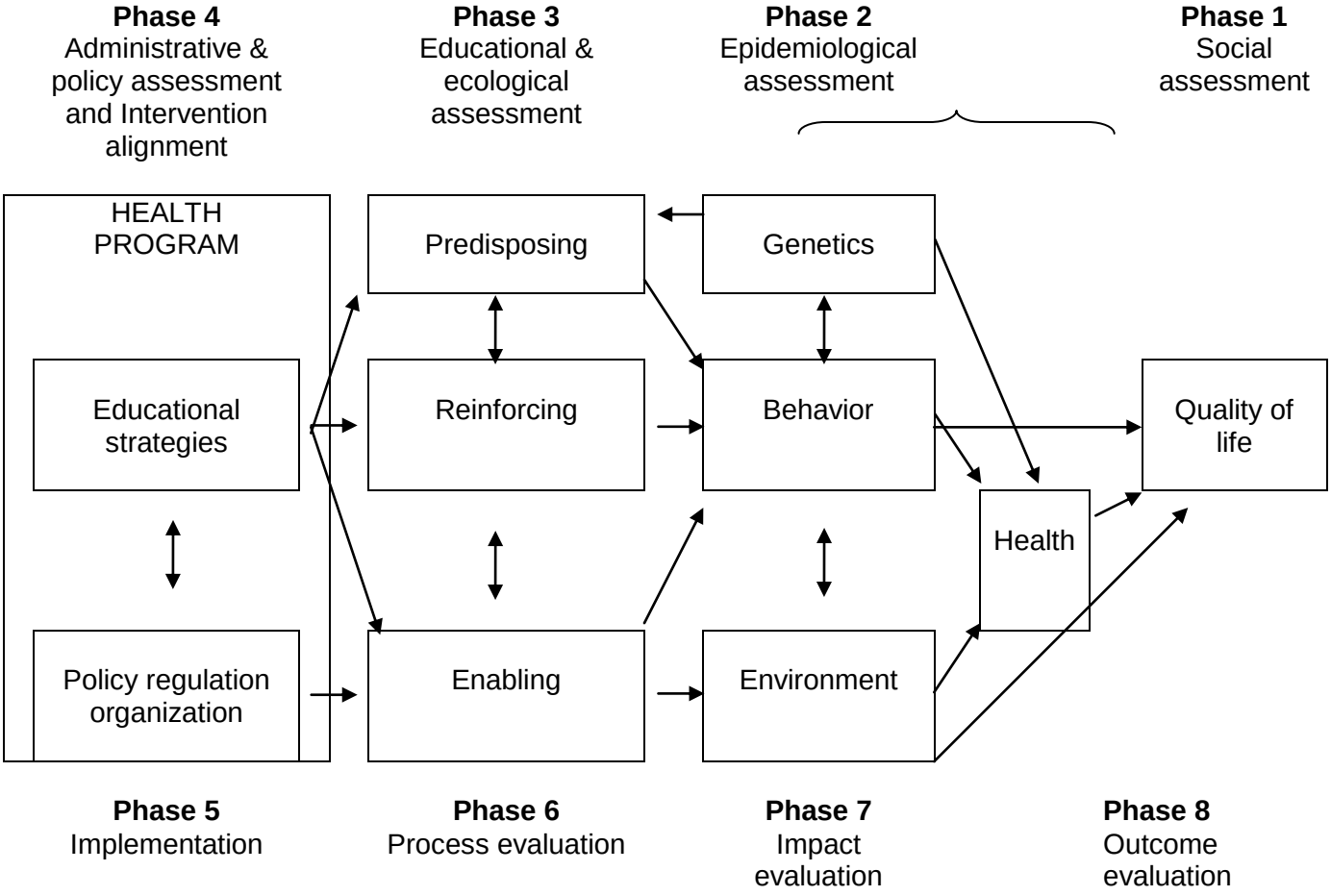
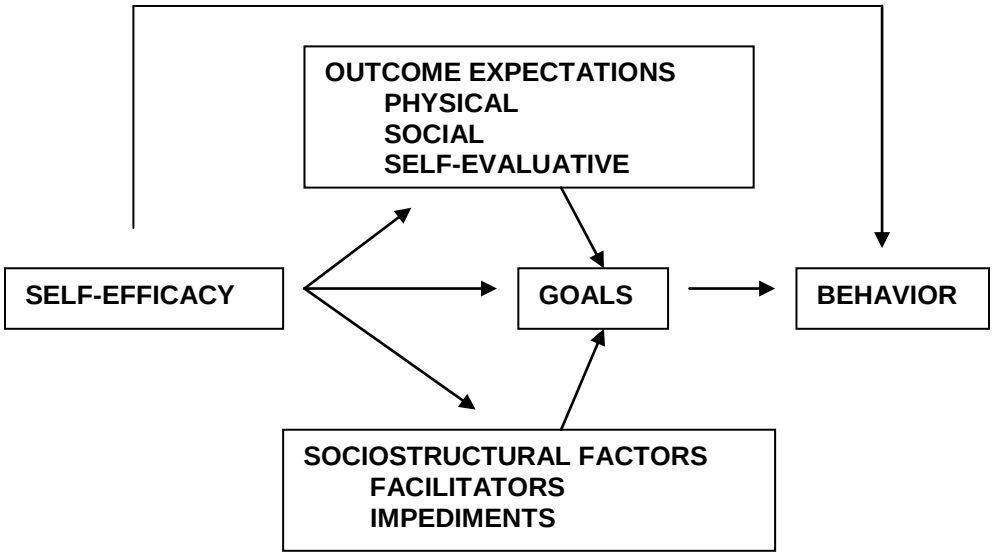


Figure 2.2: The interplay between SCT constructs and desired health behaviors [106]



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CHAPTER 3:

Study 1: Exploring prediabetes service provision using Grounded Theory

Exploring prediabetes service provision using Grounded Theory

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INTRODUCTION

The health consequences of type 2 diabetes (T2D) are substantial and include adverse outcomes such as cardiovascular disease, chronic renal failure, retinal damage, nerve damage, amputation, and ultimately, shortened lifespan [1]. Currently, it is estimated that 8% of Canadians have diabetes [2], of which 90-95% are people with T2D [3]. Canadian prevalence rates of T2D are estimated to increase up to 57% by the year 2030 [4]. Consequently, offering effective preventive health behavior interventions for those at high risk of T2D (e.g., prediabetes) may ease the public health burden associated with the disease.

Prediabetes describes individuals who have impaired fasting glucose (IFG) defined by a fasting plasma glucose (FPG) ranging from 110 to 124 mg/dl (6.1-6.9 mmol/l) and a 2-hour plasma glucose less than 140 mg/dl (7.8 mmol/l) or impaired glucose tolerance (IGT) defined as a FPG greater than 110 mg/dl (6.1 mmol/l) and a 2hPG of 140-198 mg/dl (7.8-11.0 mmol/l) [1]. In the United States, it is estimated that between 25%-40% of adults aged ≥ 40 have been diagnosed with prediabetes [5-6]. Prevalence estimates in other countries are similar. For example, between 15%-34% of individuals in Denmark have prediabetes, and between 17-30% of Australians have prediabetes [7-8]. In the absence of intervention, most people with prediabetes will likely develop T2D over time [9-10].

Several national trials have demonstrated the efficacy of individually-focused lifestyle interventions on the incidence of T2D. These studies demonstrated that if adults with prediabetes achieve and maintain a small weight reduction (i.e., ~5%), they may decrease their risk of developing T2D by approximately 58% over a four-year period [11-12]. Over the long-term, (i.e., 20-

year, 10-year, and 7-year follow-up) these studies demonstrated a 34%-43% reduction in the risk of developing T2D in the lifestyle intervention groups compared to the control groups [10, 13-14]. Behavior change pertaining to physical activity (PA) and diet were central to these lifestyle interventions. Specifically, adults with prediabetes who engaged in moderate intensity PA for 30 minutes daily, reduced their fat intake to less than 30% of calories, and increased their intake of fibre to 15 grams (g)/1000 kilocalories (kcal), were more likely to lose and maintain weight loss over time. Data also indicated that these lifestyle changes may independently reduce or delay the risk of developing T2D even in the absence of continued weight loss [14-16].

Collectively, these results provide compelling evidence that changing one's health-related lifestyle behaviors (i.e., weight loss, improved diet, PA) will likely reduce and delay the incidence of T2D over an extended period [10, 13-14]. Despite the similarities across the studies, substantial differences existed in how the intervention programs were delivered. Each program was delivered by different types of health professionals, had different behavioral goals and different methods of program delivery and resources (e.g. follow-up and access to physical activities). These prevention studies were designed to determine the efficacy of T2D prevention and were not necessarily designed to be practical for community settings [17]. While efficacy refers to how successful the diabetes intervention programs were at decreasing incident cases of T2D over the study period [18], effectiveness of diabetes prevention in community or health care settings with constraints on financial resources has yet to be determined. The impractical and cost-prohibitive nature of offering individual and intensive programs to large numbers of individuals within the target population [19]

suggests the need to explore preferred components of lifestyle intervention to provide guidance for program development implemented in a 'real world' context.

Currently, little information exists regarding the preferred components of a lifestyle intervention from the perspective of people with prediabetes. Further, information is lacking regarding how to offer practical, community-based, diabetes prevention programs that can be offered to large segments of the target population, are efficacious, are acceptable to healthcare organizations, can be implemented consistently and whose effects can be maintained over time [19]. Eliciting such information from key informants (i.e. health professionals, adults with prediabetes) has the potential to aid development of efficacious intervention programs designed exclusively for individuals with prediabetes. Using qualitative research methods in this context may facilitate the elicitation of perceptions and recommendations from both the service provider and the service consumer regarding optimal service provision. In particular, no studies to date have applied Grounded Theory methodology to develop a framework that can be used to improve diabetes prevention programs. Therefore, the purpose of this study was to employ Grounded Theory methodology to identify and examine components of a prediabetes intervention program from the perspective of people with prediabetes, as well as healthcare professionals working with people with prediabetes.

METHODS

Design

Grounded Theory

Strauss and Corbin's [20] version of Grounded Theory methodology was used. One purpose of Grounded Theory is to create a theoretical understanding within a specific social context, based on the data collected [21-22]. The

theoretical understanding is grounded in the collected data, meaning the data collection and analysis process guides the theoretical understanding [21]. Corbin [20] describes building theory as:

> "pulling all of the research threads together to construct a plausible explanatory framework" (p. 264).

Grounded Theory as described by Strauss and Corbin [21] was used in this study because it provided a methodology that was consistent with the researcher's philosophical assumptions (i.e., pragmatic), provided clear guidance on how to conduct a grounded theory study, and allowed for research questions to be defined before any data were collected [18]. In addition, using Grounded Theory to form a substantive theory was ideal as no other program development theories have been systematically defined to improve diabetes prevention programs. Another strength of using Grounded Theory in health promotion research is it allows input into the developing theory from the research participants using wording that is understandable and defined by those participants. The theoretical framework is also modifiable based on participant feedback [21-22].

Theoretical sampling

A key feature of grounded theory is the iterative process of data collection and analysis [20]. That is, data analysis begins as soon as initial data are collected and data collection and analysis continue in an iterative process until data saturation is attained. Data saturation, as described by Corbin, occurs when no new data emerges from the analyses, categories are defined and relationships between categories are well described [20]. The iterative process, central to Grounded Theory, is facilitated using the technique of theoretical sampling. Theoretical sampling means that how and who data are collected from

evolves throughout the research process to add to the relevance of the developing theory [20]. For the purposes of the current study, initially data were collected using both focus groups and individual interviews. This initial analyses of the data directed the selection of future participants. For example, health professionals were originally selected because they offered direct services to adults with prediabetes. After data were analyzed from these interviews, health professionals involved in primary care networks were also interviewed as primary care networks were identified in the previous interviews as an important component of prediabetes service provision. After these interviews were conducted and analyzed, people with prediabetes were sampled to address questions raised in the health professional interviews, add further depth to concepts and determine if perspectives varied between the two samples. Adults with prediabetes were originally recruited from one primary care network. After analyzing these interviews and the first focus group, the researcher felt additional perspectives may be gained from adults outside of the primary care network. This was done to further develop concepts and add variation to the developing theory. The interviews with prediabetes participants outside of the primary care network were analyzed and no new data emerged, no new categories were identified and the relationships between categories appeared to be well described. This is the point when it was decided theoretical saturation was achieved.

In order to triangulate the results from the interviews and focus groups, survey questions on program preferences were examined from a quantitative survey distributed to people with prediabetes. The responses from the survey questions were compared to the results from the interviews and focus groups and

added variation to the developed theory as well as corroborated the findings from the qualitative analyses.

Participants in qualitative data collection

Twenty health professionals were interviewed in the first phase of data collection using semi-structured interviews (n=8) and two focus groups (n=6 and n=6). Participants included six frontline nurses and registered dietitians, seven physicians involved in both management and primary care, and seven managers or team leaders. Managers or team leads are responsible for all staff, resources and strategic planning and evaluation for their programs. All health professionals had provided services to people with prediabetes over the course of their careers and worked in the same geographical area and within the same population boundaries. Health professional interviews and focus groups are numbered HP1 to 8 and HPFG 1 and 2 in the Results section respectively (i.e., Health professional individual interviews 1 to 8 = HP1 to HP8; health professionals from focus group 1 = HPFG1, and health professionals from focus group 2 = HPFG2).

Health professionals were initially identified for interviews through discussions with managers and frontline staff providing services to adults with prediabetes. The first author interviewed all the health professionals in private meeting rooms. Initially, only people who were offering direct services to people with prediabetes were interviewed. However, after the first three interviews were analyzed by the lead researcher, it was identified that health professionals involved with primary care networks at a management level as well as primary care physicians and nurses also needed to be interviewed to further develop the concepts that were arising from the data. Primary care networks in Alberta are typically a geographical grouping of 30-60 family physicians who are given funds from the provincial government to hire other health professionals such as nurses,

nurse practitioners, dietitians and exercise specialists to provide enhanced services to their patients. Five other individuals who worked within primary care networks were then recruited and interviewed.

After the health professional interviews were completed, 12 adults at high risk of prediabetes were recruited and interviewed using semi-structured interviews (n=7) and one focus group (n=5). Eleven participants were recruited from the same geographical area as the health professionals and one participant was recruited from a different area but still within Alberta. None of the participants had attended any prediabetes specific education classes. Participants were all between the ages of 35-75 years, spoke English, and lived independently. Eleven participants had been diagnosed by their primary care physician with prediabetes (i.e., nine participants were identified as having prediabetes from a chart review and three participants self-reported their physician told them they had prediabetes). One participant was considered at high risk of developing T2D (i.e., truncal obesity, family history of T2D, over 45 years in age, physically inactive, and had cardiovascular risk factors) and was recruited because he/she was considering medication for hyperlipidemia. Participants from the interviews and focus group are numbered PT1 to 7 and PFG1 in the Results section respectively (i.e., Participant interviews 1 to 7 = PT 1 to PT 7 and participants from the focus group = PFG1).

For recruitment of the participants with prediabetes, a primary health care network wanting to augment their prediabetes services agreed to contact adults diagnosed with prediabetes from a chart review they had performed. Phone calls were made to these individuals by the primary care network to determine if they would like to participate and nine adults agreed to participate. None of the researchers had access to this information. Originally focus groups were planned

for all prediabetes participants, however only five of the nine participants were willing to be involved in a focus group. As a result, four more participants were recruited for individual telephone interviews to decrease the time and travel burden on these four participants. The focus group (n = 5) was conducted by the lead researcher in a private meeting room and analyzed by both the lead researcher and one co-investigator before the individual interviews (n = 4) were conducted. The individual interviews were conducted by a co-investigator over the telephone and analyzed by both the lead researcher and the co-investigator.

Following the principles of theoretical sampling, after data analyses were completed with the nine participants from the primary care network, it was determined additional adults needed to be recruited who were from outside of the primary care network. Two participants, whom had been aware of their diagnosis for a number of years, were recruited via personal contacts and interviewed over the phone by a co-investigator. After analyzing these interviews the lead researcher and the co-investigator felt that someone else needed to be recruited who was struggling with the decision of whether or not to take medication for a chronic disease. The lead researcher was then able to interview a participant who was struggling with this issue. After analysis of this discussion, the lead researcher and co-investigator agreed that no new concepts were emerging from the qualitative data and data from the quantitative survey were examined.

Participants in quantitative data collection

Participants who completed the survey included individuals living in Alberta, Canada, were at least 18 years of age, had a fixed address, were able to read English and reported a doctor or nurse had told them they had prediabetes, IFG or IGT.

Data Collection

Qualitative data collection

Qualitative data collection took place from 2005 to 2008 for the health professional interviews and all the prediabetes participants were interviewed in 2008. Ethical approval for the study was received from the University of Alberta's Health Research Ethics Board and participants provided informed consent.

Health professionals participated in individual interviews that ranged from 45 to 90 minutes in length, with most lasting about 60 minutes. A semi-structured interview guide (Appendix 1) was used and focused on the following five objectives: to identify 1) what health information is currently given to clients diagnosed with prediabetes in the health region; 2) when health information is given to clients diagnosed with prediabetes and what is the referral process to the prediabetes education class; 3) what health care professionals should provide the majority of service to people with prediabetes, 4) what goals should be included in diabetes prevention programs and why or why not these goals are currently being met; and 5) the barriers that health professionals perceive influence client behavior change and prevent clients diagnosed with prediabetes from achieving lifestyle changes. Following Grounded Theory methodology, after each interview was conducted and analyzed, the semi-structured interview questions were adapted to gain additional information in specific areas including: additional barriers to behavior change, how society shapes healthy eating and PA, and how primary care networks can be incorporated into prediabetes service provision.

After the health professional interviews, data were analyzed and a focus group was conducted to provide feedback on the developing theoretical framework and to answer some specific questions raised from analyses of the

interviews. The purpose of this focus group was to determine how the developing theory worked and was relevant to the health professionals involved in prediabetes care. The focus group was about 75 minutes in length and involved health professionals from different backgrounds (i.e., physician, dietitians, healthcare managers) directly providing T2D services in the health region. A second focus group, about 30 minutes in length was conducted to discuss emerging categories. This focus group involved staff from a primary care network (i.e., physicians and healthcare managers).

Prediabetes participant interviews ranged from 20 to 90 minutes in length, with most lasting about 30 minutes. A semi-structured interview guide (Appendix 2) was used for both the focus group and the interviews. The interview guide was designed based on results from the health professional interviews and initially attempted to identify 1) the health information adults diagnosed with prediabetes had received, 2) the type of prediabetes services adults would consider optimal, and 3) the facilitators and barriers adults with prediabetes reported impacted their lifestyle changes. Additional questions were added to the interview guide on perceived seriousness of prediabetes, information needs and credibility, medication use, and effect of other health conditions on prediabetes.

Quantitative data collection

The purpose of the cross-sectional survey was to identify program use and preferences for prediabetes service provision. Individual survey questions were compiled during analyses of the health professional interviews and were based on questions that arose during the analyses and from the Precede portion of the Precede/proceed model, such as: “What is the optimal form of follow-up?; “Do most people regularly see their family doctor?”. Survey questions on program information and preferences were also compiled based on analyses of the first

health professional focus group. Questions were pilot tested by individuals with prediabetes (n = 2), members of the general public (n = 2) and academic and health experts (n = 3). Each pilot participant was asked to time themselves while they completed the survey and note any questions that were unclear, difficult to understand or difficult to read. Survey questions were modified based on this feedback. The final survey and information letter was distributed July 2008 to 1500 people who had registered in a prediabetes education class. A second mail-out to 750 randomly chosen non-responders was then sent four weeks after the first survey was mailed. Of the 1,500 surveys distributed, 1084 were not returned, 97 were returned unopened, and 319 were returned representing a response rate of 23% (319/1403). Of the returned surveys, 25 were not completed, 28 people did not report prediabetes, and 34 people reported having T2D. People not reporting a diagnosis of prediabetes (n = 28) and reporting a diagnosis of T2D (n = 34) were excluded from all analyses; representing a final sample of 232.

Data Analysis

Qualitative data analyses

As noted above, qualitative data analysis commenced as soon as the first interview data were collected and continued in an iterative manner throughout the study. The following analytic techniques were used. Initially, open coding was used to break data apart and define lower level concepts to represent chunks of data. Axial coding allowed for these lower level concepts to be connected to each other. Selective coding or integration was used to link categories together, define these relationships and present a cohesive theory. Memos were used to keep a written record of these analyses. Memos were augmented with diagrams that were a visual representation of the data analyses. The use of comparative analysis allowed for each newly coded data chunk to be compared to other

chunks of data to determine if they were similar to each other. If they were similar they were coded under the same concept and their properties were elaborated and if they were different they were coded under a new conceptual heading. Initially data chunks were compared with each other, then data from new interviews were compared to concepts from previous interviews, then these concepts were compared to each other and to other research literature. Context was explored by considering the micro and macro level conditions that arose in each category, for example questions were asked of the data such as: what social and political conditions are affecting prediabetes service provision? Theoretical saturation was reached when new interviews and data analyses did not add anything new to categories and the developing theory.

All interviews and focus groups were transcribed verbatim. Occasionally, interviews were scheduled for the same day so it was not possible to analyze these interviews before conducting the next interview. After these interviews, enough time was given for data analyses before more data were collected. Data analyses commenced with reading the entire interview before starting open coding. Each interview was analyzed by identifying natural cut-off points or changes in topic. Each line in the identified section was then examined to determine what concept(s) were emerging from the raw data. A memo with the heading of the concept(s) was then written below this section of data recording first impressions, describing the concept, discussing additional questions, reflecting on personal assumptions and discussing possible relationships to other concepts (as other concepts were identified). After initial data analysis of each interview was completed, the memos and raw data were reviewed again and concepts were renamed and linked together based on this review (i.e., axial coding). Concepts were then entered into a chart, following each interview, which

included the following: conceptual name, dimensions which used participant quotes to define each concept, additional questions that arose from each interview and how each concept was similar or dissimilar to other related concepts. This helped the researcher to constantly compare old with new data and further refine, change, and add variation to concepts. A concept was considered saturated when new interviews were no longer adding any variation or description to the concept. After the first three health professional interviews a co-investigator was consulted to help describe the relationships between concepts and tell the story of the data. Diagramming of the emerging relationships between concepts occurred and was then reviewed after interviews were completed to further describe conceptual relationships and form sub-categories (i.e., axial and selective coding). For example, concepts such as 'knowledge', 'information needs', 'trust', and 'beliefs about prediabetes origin' all seemed to be either a 'facilitator or a barrier to behavior change' in adults with prediabetes. When further examined, the properties of these categories all seemed to be related to 'confusion' or 'knowledge' in people with prediabetes and were grouped under this category.

After analyses of the health professional focus group and the health professional interviews, responses from participants who were medical doctors appeared to be negative cases as the responses given did not coincide with the conceptualizations from the other health professionals interviewed. Negative cases are those that do not fit the current pattern of the data analyses [20]. Therefore, more physicians were recruited to a second member checking focus group to further expand the current conceptualization of the data. After the analyses of this focus group were completed, it appeared no new insights were gained and concepts appeared to be saturated; this completed data collection

from the health professionals. Physicians continued to represent negative cases. After presenting the results to a group of colleagues informally, it was determined that data collection now needed to occur in adults with prediabetes to determine if this would further develop concepts and sub-categories.

After being analyzed separately, both data sets (i.e. health professional and adults with prediabetes) were then combined and compared for similarities and differences. Data from the prediabetes participants was added to related categories identified by the health professionals to further define these categories and additional categories were also formed. After the data from both samples were compared and combined, categories were integrated around core categories using memos, diagrams and another in-depth review of the summarized interviews (i.e., selective coding or integration). An in-depth examination of the research literature was then conducted and results were compared to the developing theoretical framework by noting similarities and differences between the reviewed literature and the concepts identified in this research study.

Quantitative data analyses

Quantitative survey data were then reviewed and compared to the developed theory in order to triangulate the data analyses and add further variation to the developing theory. Survey responses were initially screened for discrepant responses and missing data and entered into SPSS 17.0 for Windows. Descriptive statistics were performed.

Mixed-methods analyses

Descriptive quantitative results were compared to responses from the interviews and focus groups. Original interviews were then reviewed again to determine if any changes should be made to how the concepts were grouped

together. The co-investigators provided feedback on the theoretical framework and adaptations were made to the diagram and to category labels based on this feedback and review of the data**.**

RESULTS AND DISCUSSION

The theory that emerged from the data is pictorially represented in Figure 3.1 (A general model of how prediabetes service provision impacts behavior change). Figure 3.1 depicts how **service provision**, both effective and ineffective, influences levels of **knowledge or confusion**. Knowledge or confusion then impacts **motivational influences** such as beliefs and sociostructural facilitators and barriers. Motivational influences determine whether **goals are set** to change behavior. Whether or not goals are set directly influences both positive and negative **behavior performance**. These main categories along with their subcategories and associated concepts are described below.

Program information and preferences of individuals with prediabetes from the survey are described in Table 3.1. Participants in the survey (N=232) had a mean (SD) age of 58 (11.0) years, 73% were female, 72% were married or common-law, 88% reported descending from a Caucasian cultural background, 35% completed university/college, 40% had a family income >$80000, and 53% were currently working full or part-time. Approximately 59% were classified as obese (i.e., BMI ≥ 30), 89% reported no smoking, and about 59% reported having high blood cholesterol and/or high blood pressure. The median number of months since diagnosis was 31 months or 2.6 years.

Knowledge or Confusion

Ineffective service provision creates a lack of knowledge and high levels of confusion in both health professionals and adults with prediabetes. HP1 said

(referring to health professionals), “there is a lack of knowledge”. When more knowledge and less confusion is present, increased positive behavior performance is more likely. A lack of knowledge and high level of confusion is caused in health professionals by not being aware or knowing how to use the clinical practice guidelines (CPGs) for prediabetes and not being aware of current efficacy research. As a result, adults with prediabetes may not be provided with correct and understandable information and are not aware of specific actions they can take to lower the risk of T2D. These factors all contribute to confusion and impede behavior change.

Perspectives of health professionals

A lack of knowledge and understanding of how to implement clinical practice guidelines and current research in the area of prediabetes leads to confusion in health professionals. The Canadian Diabetes Association CPGs recommend that a “structured program of lifestyle modification including moderate weight loss (i.e. 5%) and regular physical activity should be implemented to reduce the risk of T2D in individuals with impaired glucose tolerance and pharmacologic therapy could be considered” [1]. Yet, interviews suggested that at least some health professionals are not aware of, or are not using, the CPGs: “they (primary care physicians) need to be made aware of the clinical practice guidelines and they need to test people” (HP5). Another interview suggested both ignorance of the guidelines and lack of faith in patients’ ability to change: “patients have been like this a long time and aren’t going to change and isn’t it only 5% of people with prediabetes who get T2D? Why bother referring people to a class, it isn’t going to make any difference...prediabetes and overweight isn’t really a medical problem is it? It’s a lifestyle and society problem.” (HPFG2).

While the CPGs support the practice of providing programs to people with prediabetes, no specific actions (i.e. increase endurance activity or increase fibre intake) are recommended that can guide health professionals in supporting a person with prediabetes to change the required health behavior to reduce their risk of T2D. As HP1 said, “you can’t give a nebulous goal of eat healthy”. The lack of clearly defined actions creates confusion about how to help people with prediabetes change their behavior to lower their risk of developing T2D. HP1 reflected, “you have to get to weight loss through healthy eating and physical activity…but I don’t know how you provide a goal for healthy eating”. For physical activity, although seen as essential (e.g. HPFG1, “exercise is a key ingredient”), none of the participants listed current public health guidelines of 150 minutes most days of the week. Suggestions included; HP1: “six days a week of exercise of forty minutes to walk four kilometres”; and, HP2: “regular physical activity”.

A clear example of confusion of the current prediabetes research and what adults with prediabetes may prefer is reflected in the following quote from HPFG2: “I am a big believer in prescribing Metformin...Metformin should be the starting point because it helps with weight loss. If the patient doesn’t want to take Metformin then we should put more emphasis on the diet and exercise stuff.”. Current prediabetes research has demonstrated lifestyle interventions more effectively decrease T2D risk and cardiovascular risk factors than Metformin (i.e. 58% reduction in risk over four years versus 31% for Metformin) [12-13]. In the interviews, adults with prediabetes generally did not want to take medication like Metformin and wanted more guidance on how to make lifestyle changes. PFG1 said, “I want to control my prediabetes with diet and exercise before I go on medication to give me a chance.”

In our study, health professionals who were more supportive of preventive services also reported better knowledge of current research in the area of prediabetes. HP2 stated, “if you can prevent disease you should do everything you can to prevent disease and to have a better quality of life”. HP3 stated, “we need to really drive home the message that diabetes is preventable... diabetes is a bad disease, and so I get quite excited actually about prevention because I think there should be more happening.”

Other studies involving health professionals providing services to people with prediabetes have also identified confusion limits the provision of services [23-25]. A study by Evans et al. [25] suggested that when confusion was resolved by offering an education program and written patient resources to health professionals, their support for offering prediabetes services increased. Further, family physicians and nurses found they were able to manage their prediabetes patients within their time constraints despite their documented concerns [25]. Similar to our study, Evans et al.[25] and Wylie et al. [24] reported the health professionals they interviewed also would like a list of specific clinical practice guidelines to provide direction when dealing with people with prediabetes in order to decrease confusion [24-25]. However, no published prediabetes guidelines were specific enough to guide practitioners [24]. Based on the results from these studies and the current study it appears CPGs are not specific enough to guide researchers, health professionals or program designers when developing interventions for the prevention of T2D.

Perspectives of adults with prediabetes

In adults with prediabetes, interviews suggested confusion occurs when no information or incorrect information is provided from the primary care physician. When PT2 was asked about what information was received about

prediabetes when they were diagnosed, they responded, “I haven’t had any to tell you the truth”. Incorrect information, such as incorrect terminology being used, mislead participants as PT1 reports: “I was told I had borderline diabetes so I got information about diabetes.” Few of the adults interviewed understood the differences between having prediabetes and T2D as PT2 commented, “I’m always cutting myself, and I heal very quickly so to me that’s a sign that I’m in trouble or I don’t have it.” They also did not understand that prediabetes was a serious diagnosis as PT1 said, “I don’t think this (prediabetes) is serious because I don’t have any symptoms I might have if I had something else.” Much of the advice adults with prediabetes reported being given by their primary care physician (if they were given any) was inconsistent with CPGs as PFG1 commented, “the only advice I got was not to eat potatoes because he knew I loved potatoes.” As well, PT6 shared, “I was told to start using a glucometer and attend a diabetic clinic”. While adults with prediabetes reported high levels of confusion, PFG1 said, “I mean I don’t know what foods I’m not supposed to eat...I mean, I’m staying well. I’m still okay so I’m eating the same foods.”, primary care physicians reported strong beliefs that their patients were very aware of what they needed to do as HP1 reported “they’ve (patients) got the knowledge or the information, they know what they’re supposed to be doing”.

From the adult with prediabetes interviews, it appeared they had gathered information from different sources and this information either impeded or enhanced behavior change. First, no information was gathered because the patient was unaware of their diagnosis, did not perceive it as serious (i.e., PT1, “I don’t think prediabetes is a serious disease”), or felt it was inevitable due to family history (i.e., PT1, “Well I thought it was basically all, a bit hereditary”).

Therefore, very few behavior changes were made based on their prediabetes diagnosis.

Second, the patient gathered information from the world around them (e.g., the internet, family and friends, books from the library, health food stores, radio stations, pamphlets) but they were not really sure if the information was credible or not. Therefore, they did not change their behaviors. In the interviews, these people reported a high level of fear of getting T2D as PT5 said, “it is a death sentence” and expressed frustration about not knowing what to specifically do about it. If people who gathered information from their friends and family had positive T2D role models they reported less confusion and were practicing more healthy behaviors than people who had negative role models. As one participant who had a negative role model and was not making any positive changes to her lifestyle said, “I’m actually confiding in an older friend and she has got diabetes...I know her diet is totally off whack” (PT5).

Third, the adult with prediabetes gathered specific information from people they trusted. These included their family physician, another health professional, or someone with prediabetes or T2D who was successfully managing their disease without medication. This participant discussed how he received information about diet and exercise from “the dietitian friends that I have” who were seen as a credible source of information and as a result reported “I’m going to do everything I can to prevent that (referring to T2D)...diet, exercise, lower my cardiac risk factors.” (PT6). Information was seen as credible when recommended by a trusted health professional or when the adult implemented the information and the change in behavior resulted in the expected outcome as PT3 discussed “I’ve been taking my herbs for a year...I probably wouldn’t be here today dear, is what I’m saying...” The interviewer then asked, “So you think that

they must be giving you correct information if it's working right?" PT3 responded, "Why, yes."

Motivational Influences for Behavior Change

Both health professionals and adults with prediabetes identified different motivational influences that impeded or enhanced their behavior change. These included both positive and negative beliefs, perceived facilitators, and sociostructural facilitators and barriers.

Beliefs affecting adults with prediabetes behavior change

Beliefs are key constructs in behavioral theories, influenced by knowledge levels, that can either positively or negatively influence behavior performance [26]. Some key beliefs identified in the interviews (e.g., changes not pleasurable, too difficult) discussed reasons why behavior changes were not easily made, "if exercise was as pleasurable as eating and eating was as onerous as exercising there would be no obesity" (HP1) and PT4, "I don't want to stop eating dark meat". People struggling with positive behavior changes reported low self-efficacy (an individual's belief in their ability to perform an action [26]) for the changes they found difficult, "I could always lose more weight, but I think, I think the exercise is easier to change than diet." (PT6). Adults with prediabetes identified a number of barriers to their behavior change in the interviews including one man's inability to control his portion sizes because his wife cooks him too large a portion of meat at supper, not having time to be active, too much stress to make changes, not being able to refuse food when visiting someone's house or when bored, having a large appetite so being unable to limit portion sizes, or being too lazy to increase physical activity. Health professionals also reported the most common barriers they felt their patients experienced included: people not knowing what they are doing wrong or how to change, patients not understanding

the long-term implications of their disease, people feeling overwhelmed by information, and people feeling discouraged about weight regain. In other research, negative beliefs or perceived barriers to performing behaviors similar to these have been demonstrated to negatively impact behavior [27].

Some of the reported beliefs acted as facilitators to behavior change. For example, the belief that "living 20 years healthy versus miserable" (PFG1) was given as motivating by people who were making positive behavior changes. Another interview discussed how perceiving necessary behavior changes as easy and pleasurable was motivating, "I am physically active because it makes me feel good (PT4)". Also, adults reported the support of others (e.g., going for walks with them or preparing healthy meals) influenced their behavior change, "I haven't been exercising as much as I normally do because my wife, she usually walks with me, but has a bad knee" (PFG1).

Beliefs affecting health professionals service provision

Health professionals reported negative beliefs about their role in behavior change as members of the healthcare system, "I don't think that, um, as a healthcare system, we've got a good grip on it yet….what motivates people to change, and then if they're motivated, how best to serve them" (HP6). Some ideas about increasing motivation for behavior change were provided in the interviews (e.g., promoting that T2D is preventable), but were often accompanied with feelings of not really being sure if this was the "best way" (HP6). Health behavior constructs such as self-efficacy (e.g., HP1: patients think, "what's the use I'm never going to be able to do it"), perceived risk and fear resolution (e.g., HP6: "they understand the words, but I don't think they've bought into the long-term implications.....then they have an event or somebody's died"), mental health (e.g., HP3: emotions "get the better of their eating habits"), intrinsic and extrinsic

motivation (e.g., HP1: “people don’t like weight watchers because of the negative versus positive reinforcement” and HP1: “they probably already know the information...it’s the motivation that’s the challenge”), attitudes (e.g., HP4: patients see change as “huge, ugly and enormous” and HP3: we need to identify a belief for patients that will “keep them going...an aha moment”), social support (e.g., HP2: “It is very difficult for people to make changes if their family is not willing to make the changes with them”) and perceived behavioral control (e.g., HP4: need to find things that work for the individual, “with what they have and how they can manage”) were identified by the health professionals as being individually motivational. However, in the present study as well as previously published research [25], health professionals felt unable to change these constructs to improve behavior performance.

Perceived facilitators of behavior change

The interviews identified a number of different methods that could be used to increase motivation or change behavioral constructs. In the interviews, both health professionals and adults with prediabetes highlighted the need for self-monitoring to be incorporated into prediabetes prevention services to facilitate behavior change, “when people change their behavior they start seeing outcomes and this moves them towards making a change” (HP2). PFG1 reported, “I certainly found with my husband...thought he had to test every day you know...around Christmas time his level crept over 7. He was gone practically an hour and came back. It was amazing how much the level fell because he went out and had a walk”. Health professionals also highlighted the need to give patients small, specific changes they could experience success doing, HP1 said, “The literature says to focus on one specific thing at a time”, HP4 shared, “I get people to go up and down their stairs three times to get 15 minutes of exercise”,

and HP2 commented, “giving out general information is not effective”. The interviews suggested that health professionals providing patients with motivational materials and key messages would enhance behavior change, “change the wording to...motivation to prevent diabetes by losing weight...because the motivation is to prevent diabetes, they’re not really motivated to lose weight necessarily” (HPFG1). Developing a personal relationship with the patient was also seen as important, as HP2 commented, “so that personal relationship is motivating...having them see you and forming that bond...give positive feedback when changes happen.”

Sociostructural facilitators and barriers

Sociostructural facilitators and barriers impact behavior change but are externally controlled from the person with prediabetes. These primarily include the structure of the healthcare system and society.

In the interviews, participants identified a number of areas healthcare systems impact behavior change in people with prediabetes. Both access to interdisciplinary teams “like a dietitian for more specific information” (PFG1) and knowledge of prediabetes programs were identified as important influences on behavior, “we don’t know where to refer people...There is an IGT class? How long has it been running? I wasn’t even aware of it.” (HP7). In the survey while 66% of participants had visited their family doctor in the previous year, only 47% had actually discussed their prediabetes. One possible explanation provided by the health professionals is primary care physicians do not have time for discussing prevention, “they (family physicians) just don’t have the time themselves to do anything...and potentially the expertise (HP1)” “they only get reimbursed for a 15 minute visit.” The interviews identified a healthcare team made up of a primary care physician, a nurse or exercise specialist (i.e.,

kinesiologist) and a dietitian would be the optimal core team to provide prediabetes services with access to other professionals (e.g. mental health or social work) as needed, as HP8 said, “if my mother had IGT that’s what I would want for her”. However, incorporating an interdisciplinary team was not supported by the physicians interviewed, “I know the studies...people going in to see a dietitian know as much coming out as they did when they went in” (HP1) and, “I don’t know if that’s how we do it effectively” (HPFG2), referring to involving other health professionals in the care of people with prediabetes.

Incorporating electronic facilitators into primary care practices (e.g., HP6: “I don’t see the health system reforming without using an electronic chart”) were also identified in the interviews as helping family physicians manage their patient load (e.g., HP6: “we need an electronic system that won’t over diagnose to prevent people from falling through the cracks”) and use appropriate clinical practice guidelines (e.g., HP6: “the electronic chart should also include decision support tools...currently CPGs are not in a useable format for family docs”). Other enhancements to patient care identified in the interviews included using electronic charts to provide recent laboratory data, detail places other medical visits have occurred or information has been sought (e.g., emergency room, health information help lines), provide links to community resources, and provide information packages to the patient at diagnosis.

Health professionals viewed evaluation of the program as an important component of any prediabetes service provision to decrease confusion and to increase health professionals’ motivation or willingness to provide preventive services. HP3 states “you know we were actually thinking of doing a bit of research, doing a little bit of follow-up to see where people were at. I would have loved to have seen the data, but it didn’t really go anywhere”. Some of the

confusion about service provision the health professionals expressed was because no evaluation had been completed, as HP8 reported, “we haven’t evaluated anything fully yet so I don’t know what the best way is to reach people”. While a prediabetes education class had been offered for approximately the last five years, no one knew if it was effective or not. HP8 commented, “I don’t know if the classes work because there has been no evaluation on how people respond or what works for them”.

A number of structural barriers were identified in the interviews. Increased workload concerns were prevalent, “more individualized care is better, but I don’t know if that’s possible depending on care providers in terms of staffing” (HP4). Concerns about workload and diversion of resources from other programs have also been reported in other research in health professionals to decrease support for provision of prediabetes programs [24-25]. Other concerns identified in the interviews by health professionals included lack of access to family physicians, lack of proper use of family physicians (e.g., no yearly physical, only attending a Medicentre), lack of childcare to attend education programs, and lack of culturally appropriate care (e.g., HP6: “do you know we have 14 primary language groups and we don’t even consistently provide service in French....we’re pretty good for middle class, English speaking white people.”)

Participants also felt that societal structure should improve to make healthy choices easier in order to decrease rates of obesity and prediabetes, “society’s not and hasn’t provided settings for living healthy” (HP8) and, “the only thing that’s been shown to change behaviors is money...you know this idea of a sin tax on junk food” (HP1). Societal barriers to healthy choices were seen as: unsafe communities, communities with low walkability, the financial costs of healthy food choices and PA community programs (e.g., HP4 said, “it is cheaper

to buy Coke than fruits and vegetables and milk."), easy access to unhealthy choices (i.e., HP7 said, "it is cheap and very accessible to eat at McDonalds, I can walk across the street."); workplaces that provide no support for time off for doctor's appointments or for people to attend health education classes and, pressure to produce and achieve in North American society leaves no time to prepare healthy food and be physically active, " in Europe, people just lead a little bit more slowly paced lives, focused more on food, I think they do eat, um, a large part better than we do in North America because they... just have a slower pace about them...and understand the importance of food,... and in, in North America, it's just go, go, go, quick, fast, hurry" (HP8). Ideas to facilitate behavior change included banning unhealthy choices such as trans fats, offering coverage for obesity medication and diabetes tools like blood monitors and strips, and creating political will for these changes using economic rationale by "providing a dollars and cents amount (HP7)". Ideas for making healthier choices easier from the adults with prediabetes included teaching healthy eating in schools so children would not develop chronic diseases like prediabetes (e.g., PFG1: "education should start with school, you should teach people about things they may never need to know, so when the time comes you have it"), and increasing access to PA opportunities (i.e. put treadmills in family physician offices).

Health promotion activities to increase awareness of prediabetes and the need for screening were also seen as an essential ingredient in T2D prevention. To increase awareness, health professionals mentioned using social marketing campaigns focused on helping people to identify if they are at risk for T2D to encourage them to make an appointment with a physician to get screened. This was a strategy to extend the reach of a prediabetes prevention program to include people who may not see a family physician regularly. Other ideas

included connecting with local community agencies within the primary care network to pass information on, or advertising risk factors through various mediums (e.g., social networking, pharmacies, grocery stores).

Goal-Setting

A number of participants spoke about the importance of goal-setting in the behavior change process to increase positive behavior change. As HP6 comments, “develop knowledge by providing information, then develop skills...to accomplish the goals they have set out for themselves...and ability by increasing their ability to self-manage, develop goal-setting skills, address relapse, and cope with their condition.” Interviews suggested that if individuals set specific goals for themselves, this is a reflection of positive beliefs of the outcomes of behavior change, “if these are the changes I make, these are the benefits I will get” (HP2). HP3 reflected, “setting one goal with a patient at a time is the best way to do things so people don’t get overwhelmed. If they are successful then they usually want to move on to do more than one goal”. In one interview after hearing about the benefits of physical activity in the prevention of T2D (i.e., increased knowledge), one participant wanted to then set a goal, “this year I will join the YMCA and start exercising” (PFG1).

Goal-setting also may help adults with prediabetes know what they are supposed to change (e.g., PFG1: I mean I don’t know what foods I’m not supposed to eat”) and, set priorities when they have multiple health conditions (e.g., PFG1: “You know I did some looking, because of course of having to combine things for the heart with the diabetes complicated a whole bunch of stuff. And I just know that I do read the labels and what I did find interesting. Because the nurse was focusing on the heart, you know low salt. I suddenly discovered the sugar levels were higher in those that were low in the salt. It’s like,

why, you know like, why couldn't we just come up with something that had both of them." Participants who were more aware of what they should do, were more able to set goals and consequently were more likely to be performing positive behaviors.

Service Provision Strategies

The following service provision strategies are compiled from our qualitative and quantitative data analyses as well as other research literature on people with prediabetes. Figure 3.2 describes how the seven strategies outlined below address the limitations presented by high levels of confusion, motivational influences that negatively impact behavior change (e.g., barriers) and a lack of goal-setting. If these strategies to improve service provision are implemented, we anticipate more effective service provision should result which may lead to increased behavior change.

Strategy 1: Provide an education program to health professionals providing services to adults with prediabetes

Based on the results of this study and previous research [24-25] it appears an education program for health professionals is an important component of any prediabetes intervention to decrease confusion and increase knowledge. Ideas to include in the education program include providing an in-service on the clinical practice guidelines, provision of a laminated single-sheet clinical practice guideline, identification of prediabetes services and a discussion of how prediabetes materials can be used to decrease workload. Another idea generated to address confusion in primary care physicians was to provide additional emphasis in medical schools about the importance of prevention, "We aren't teaching medical students anything about prevention and the importance of early intervention, they will probably see obesity related chronic disease for

80% of their practice but they get one two-hour lecture about it. We give them hundreds of hours of pharmacology, what drugs to use but no time for the lifestyle aspect" (HP1).

Strategy 2: Provide a standardized education program to adults with prediabetes.

To overcome the confusion and negative beliefs identified in this study and previous qualitative research in adults with prediabetes [23, 25, 28], a multi-faceted program should be offered that includes providing services at three stages: diagnosis, referral for further education, and follow-up. Any intervention offered would likely benefit from incorporating methods to change cognitive constructs that influence behavior change. Health behavior theories containing these constructs such as Protection Motivation Theory, Social Cognitive Theory, Theory of Planned Behavior and Self Determination Theory have been demonstrated to promote behavior change [27, 29-31] and their application to prediabetes prevention services warrants further examination.

Diagnosis

At diagnosis, participants recommended the family physician provide some key messages and relevant information about prediabetes to their patient in both a written and verbal format to increase behavior change, "people should receive education as soon as possible...one thing I do find is people that have a good relationship with their family doctor and really trust that person make behavior changes based on what their family doctor said" (PT2). PFG1 said, "they should provide some simple information when they told me my blood sugars were high. I want to be able to ask my doctor questions and have them tell me what to do". Adults with prediabetes emphasized that what their primary care physician told them to do was important to them and were able to facilitate behavior change when the message was personalized to their habits and not just

a general message such as eating better or losing weight, “they (doctors) should realize that they bring a certain concept to a patient, the patient will take that as a rule. Most of us.” (PFG1). Supporting the qualitative findings, survey participants wanted education from a health professional (86%) and someone who gave them specific instructions (57%).

Evans et al. [25] also demonstrated that providing key messages at diagnosis was a successful method of increasing knowledge and decreasing confusion in people with prediabetes. Another possible benefit to the physician having a brief discussion with the patient is that as people have increased awareness of how to influence their risk of developing T2D they also appear to accept greater personal responsibility for the outcome of their illness [32].

The health professionals and adults with prediabetes made a number of recommendations on topics to discuss and provide in written materials at the diagnosis appointment. Focusing on the key message that T2D is preventable seems particularly important to provide at diagnosis to promote positive beliefs such as hope, and decrease feelings of inevitability. Troughton et al. [23] also identified that any prediabetes written materials given need to provide specific information seen as relevant to the person reading it. Information seen as important to discuss and include in written information identified in the interviews and other research [23, 25] includes 1) why people get prediabetes, 2) current research on prediabetes, 3) what happens in the body of someone with prediabetes and how this is influenced by lifestyle behaviors, 4) specific lifestyle goals the person with prediabetes can begin to work towards, 5) how medication can be used in the treatment of prediabetes, 6) links to community resources for more information, and 7) a motivational message about how and why people should attend an education class or follow-up appointment. At diagnosis, after

discussing and providing a written summary of these points the physician should then ask if the patient has any questions about their diagnosis, communicate that prediabetes is a serious condition that leads to T2D if specific lifestyle changes are not made, and provide the patient with a referral for further education.

Translating written information into different languages for provision to people who do not have English as their first language would also be beneficial. In Canada, approximately 48% of those 16 and over read below a level three literacy level [33]. Level three literacy is considered the desired level of literacy for coping in a knowledge-based society [33]. In order to accommodate lower literacy levels within a diabetes prevention program it has been established that written education materials should be designed at a grade five reading grade level or lower, and all materials should achieve a superior score using a suitability assessment of materials measurement tool [34].

Referral for further education

After diagnosis and based on the learning or motivational needs of the patient, the physician should provide a referral to either a group education class or a one-on-one appointment with a member of the prediabetes healthcare team. Small group education sessions (i.e. 8-10 people) were generally seen as a first step for further education by the health professionals due to concerns about the numbers of people needing to be seen, “we do know that group counseling is effective. We don’t have enough dietitians to see everybody one-on-one” (HP1). For some people with multiple barriers (e.g. financial, literacy problems, multiple health diagnoses, mental health diagnosis) or who desire more specific information it was felt that one-on-one services should be available. For example, people experiencing financial barriers may need more advice tailored to their situation, “not knowing where the rent money is going to come from or the next

meal puts health much lower on the priority list of things to think about" (HP1). In the survey, approximately 60% of participants wanted to learn more about prediabetes in an education class, 42% over the internet, 50% from their family doctor (supports offering some one-on-one services) and 30% from a DVD. The best time for an education class was during the week (79%) from 9:00 am to noon (55%) or 1:00 pm to 5:00 pm (28%). The preferred location for the class was a community health centre (68%) or a hospital (61%), however participants also preferred attending a class at a community location such as a school (45%) or library (38%).

Content of further education

The education program content should reflect the goals of T2D prevention of weight loss, physical activity, healthy eating and pharmacologic intervention. To decrease confusion, the information provided about weight loss, healthy eating, physical activity and medication should include specific recommendations an individual is able to apply to themselves. Providing specific guidelines that fit into individuals' current lifestyles without a real loss of enjoyment are recommended, "I really believe that everybody's different, everybody comes from a different background, has cooking skills or no cooking skills, has a different budget, knows what their likes and dislikes are, knows what they can fit into their day, knows what they can handle and deal with as far as stress goes, and it has to be individualized." (HP4). In addition, asking people to pay attention to how they feel after they have made good choices and involving supportive family and friends in the education session were suggested in the interviews as methods of increasing motivation for behavior change.

The barriers to behavior change identified in the interviews should be discussed in the education session. Participants should then be encouraged to

problem-solve around the barriers they experience. Additional barriers identified By Andersson et al. [32] may also be discussed such as guilt for not doing enough to lower blood sugars, setting impossible goals, and lack of enjoyment of healthy eating and physical activity.

Andersson et al., [32] found that people diagnosed with prediabetes needed to evaluate their former habits to identify what habits were contributing to their illness for them to be able to make lifestyle changes. The health professionals in our study also emphasized how important it was for people to identify in their current lifestyles what they need to change. In order to help people with prediabetes evaluate areas they need to implement behavior changes, it may be helpful to incorporate an evaluation of former habits into a group session by encouraging participants to fill out an assessment quiz that helps them to identify what specific behaviors they need to change.

Follow-up

To further decrease confusion and increase positive motivational influences, the final recommended step identified in our interviews, as well as other research [23, 25] would be scheduling a follow-up appointment (after the education session) with a member of the primary health care team based on the needs of the individual. However, the optimal length and timing of follow-up has yet to be determined. Previous research in adults with prediabetes has demonstrated that an annual check-up is not enough follow-up to facilitate behavior change [12]. At the first health professional focus group (i.e. HPFG1), different follow-up schedules were discussed and the consensus within the group was that follow-up should include at least a monthly or bi-monthly visit within the first year and continue for three to five years to help patients adopt and maintain behaviors. In the survey, 79% of participants wanted further follow-up supporting

the results of the interviews and focus groups. Approximately 58% of the sample wanted follow-up to occur monthly for the first six months, then once every six months. This is similar to the above recommendation of follow-up occurring monthly.

Follow-up would best be offered by the primary health care team that already has an established relationship with the adult diagnosed with prediabetes, “that personal relationship is important, motivating. Having them see you and forming that bond so they know you’re involved and are their resource person” (HP5). It appears optimal to provide a variety of options for follow-up such as accessing a health professional for one-on-one follow-up (either face-to-face or via telephone), accessing resources and information that people can access from home by themselves such as an internet site, linking people to support groups for weight loss, linking people to culturally appropriate resources and resource people, providing educational DVDs on additional topics not discussed in the education class, telephone counseling, newsletter mail-outs, and referring people to community resources like grocery shopping tours and exercise classes. In the survey, many of the participants wanted follow-up from their family doctor (38%), from a telephone call with a health professional (40%) or from emails with a health professional (38%). As identified in the current study the necessary follow-up protocol is likely different for different individuals; therefore one optimal follow-up prescription may not exist and may need to be flexible. Additional research needs to examine the usefulness of written education materials used in combination with pedometers or other self-monitoring tools, effectiveness of telephone counseling, and use of electronic tools such as the internet to minimize healthcare resource use. Interestingly, a recent study

identified that offering behavior therapy to achieve a very small weight loss by mail was as successful as offering it using telephone counseling [35].

Incorporating self-monitoring was identified in our interviews as an important facilitator of behavior. Self-monitoring should be encouraged in the follow-up portion of prediabetes service provision. A number of self-monitoring methods were identified in our interviews that may increase motivation for behavior change. These include: teaching people how to monitor their waist circumference and fasting blood sugars; supplying health professionals with equipment to monitor blood pressure and cholesterol levels in their offices when people come for appointments; having laboratory values available for follow-up appointments and tying these to the behaviors the person needs to change; using pedometers to track step counts; and (over the first year) doing glycosylated haemoglobins every three months.

Strategy 3: Incorporate an interdisciplinary team with clearly defined roles.

The optimal role for the family physician would be to screen adults, provide information at diagnosis, provide a referral for further follow-up, and provide monitoring of laboratory values or medication use when necessary. After interviews with healthcare professionals and people with prediabetes, Evans et al. [25] also identified these roles being performed by general practitioners. The role of other health professionals (i.e. nurse educators, dietitians, exercise specialists) would be to provide further education, support for behavior change, and follow-up services. HP5 stated “the role of a nurse in a family practice clinic should be primarily teaching and using nurses for office work is a waste of money. There’s no reason why nurses cannot manage that piece (referring to education) in collaboration with a physician. Let docs deal with the acute problems”. In the interviews both health professionals and adults with

prediabetes identified some specific personal characteristics people providing prediabetes services would benefit from, “someone who makes practical recommendations, who understands all kinds of people, someone who has had personal experiences that have led to change themselves, someone who recognizes how they feel when they do things better, who isn’t judgmental, is compassionate and has some life experiences.” (HP2). Recent research has reported no significant weight loss differences between people who were provided a consistent message and seen by a dietitian in a group setting and those seen by a nurse or physician in a clinic setting [36]. This supports the important role physicians and nurses can play in primary care clinics.

To cope with the lack of support from physicians for incorporating a interdisciplinary team identified in this study, it may be helpful to facilitate a discussion between the primary care physicians involved in care and the other health professionals to clearly define roles and discuss how to work together as a team [25].

Strategy 4: Incorporate the use of an electronic chart and tracking system.

Electronic facilitators were identified by the health professionals as something that is necessary to provide more effective prediabetes services. Another study also identified electronic facilitators as being important to improve patient care and track patients with prediabetes [25]. Electronic charts in other healthcare settings have been used to remind family physicians when to screen people for prediabetes, provide reminders for follow-up appointments and ensure people are getting connected with additional services [37]. Incorporating clinical information systems (as one aspect of a chronic care model) into healthcare systems has been identified as an important aspect of managing chronic disease

[37-38] that is able to enhance T2D management services and positively impact laboratory values [39-41].

Strategy 5: Incorporate a formalized evaluation protocol.

In our interviews both health professionals and adults with prediabetes felt evaluating any prediabetes service provision was important. Incorporating evaluation models such as those discussed in the RE-AIM framework (i.e., reach, effectiveness, adoption, implementation, maintenance) [19] have demonstrated efficacy in evaluating the public health impact of health interventions. Incorporating these evaluative frameworks would likely be useful in the evaluation of prediabetes programs.

Strategy 6: Design a consistent program centrally

The overall design and evaluation of the program and materials for the program (e.g. community resource listings) was seen as the role of a regional or central authority who would then disseminate the program locally to primary care networks for implementation, as HPFG1 said, “I like the idea of a formalized program for prediabetes so PCN (primary care network) staff know what they are supposed to do with people diagnosed with prediabetes”. This could decrease confusion, promote consistent service provision across a health region, and ensure the program was designed using current research and clinical practice guidelines.

Strategy 7: Promote societal change

While health professionals did not appear to consider themselves as directly having an advocacy role, they identified the need for someone to create the political will to address the problem of overweight and obesity, and thus prediabetes. Creating social change is complex and health professionals within an organizational structure are limited in their ability to advocate for change

outside of that organizational structure, even though they are able to identify factors they believe are barriers to making healthier choices. Ecological models of behavior consider how individuals interact with their biological, psychological and environmental context [42]. Their further application should be considered to address the problem of unhealthy eating and physical activity behaviors in order to promote societal change.

CONCLUSIONS

This study aimed to organize the components of optimal service provision of prediabetes intervention programs into a Grounded Theory. Figure 3.2 provides a detailed summary of the potential relationships between ineffective and effective **service provision**, **knowledge or confusion**, **motivational influences**, and **goal-setting** and their impact on **behavior performance**. Figure 3.2 also highlights the role service provision strategies play in prediabetes care. Firstly, ineffective service provision (i.e., does not provide education and training on prediabetes for health professionals or a standardized program for people who are diagnosed with prediabetes) leads to low levels of knowledge. This results in high levels of confusion for both health professionals and adults with prediabetes. Confusion and lack of knowledge appear to result in negative beliefs about the importance of behavior change and the importance of providing intervention to those diagnosed with prediabetes. Health professionals and patients who have negative beliefs also have higher levels of perceived barriers to providing prediabetes services and to changing behavior. Individuals and organizational structures that do not place importance on prediabetes treatment are not likely to set specific goals to improve service provision or to change behavior. This results in low levels of behavior change. When strategies are implemented to improve service provision, this can change the above factors to

lead to increased behavior change. Implementation of these strategies should increase the level of awareness of specific behaviors to change to prevent T2D and increase knowledge of current research outcomes and clinical practice guidelines. This results in decreased confusion and leads to more positive beliefs about the importance of intervention in people with prediabetes. Increased knowledge of specific behaviors to change also increases the ability of adults with prediabetes to problem solve to overcome their perceived barriers. Individuals who have positive beliefs and problem solving ability are able to verbalize specific goals they are doing to try to reduce their risk of T2D. These individuals appear much more likely to perform positive behaviors that impact their prediabetes.

Strengths and Weaknesses

The qualitative approach used in this study enabled a richness in data collection. Data were analyzed using a constant comparative method as described by Corbin and Strauss [20] to develop concepts into categories with defined dimensions until data saturation was reached. This method has allowed for the construction of a substantive Grounded Theory that may be considered when developing diabetes prevention services within similar contexts. Substantive grounded theories are not meant to be generalizable across contexts [43]. Data collection and analyses were based on participants' own experiences and compared the different beliefs of health professionals and adults diagnosed with prediabetes. The small sample of adults with prediabetes, while chosen using the principles of theoretical sampling, did not include many racially diverse individuals. Therefore, the transferability of our results is limited. Although other studies conducted in other samples of adults with prediabetes (some samples were ethnically diverse) and health professionals identified very similar themes

[23-25, 32]. For the adults with prediabetes, all data were analyzed and discussed by two researchers to minimize individual bias. However, it was not possible to recruit a sample of adults with prediabetes for a focus group to discuss the developing theory as the majority of individuals only wanted to participate in individual telephone interviews. Only one focus group was conducted in adults with prediabetes and this allowed for interaction between participants, one advantage of conducting focus groups [44]. In the following individual interviews we were able to gather more in-depth data from people and explore the concepts identified in the initial focus group. For the health professional interviews, open coding was done by only the primary researcher but concepts and their relationships to other concepts (i.e., axial and selective coding) were discussed and developed in consultation with the other co-investigators. After data were organized into themes, focus groups were conducted with health professionals to discuss the applicability of findings.

Using the qualitative analyses to direct survey questions garnered a broader range of perspectives on points of contention that arose during the qualitative analyses. For example, some of the health professionals reported their patients would prefer to take medication than attempt lifestyle changes. This prompted the researcher to ask in the interviews with adults with prediabetes if this was an accurate observation. After many of them disagreed with this observation, some interview questions were then compiled and a person was interviewed who was struggling with the decision whether or not to take medication. The researcher asked, “What influences your decision on whether or not to take medication?”; “What did your doctor say about taking medication?”; “How would you know if taking medication or taking a natural supplement is working?”; and, “Why does taking a natural supplement pill seem better than

taking a drug pill?". Limitations of the survey include the low response rate. This limits the ability to draw conclusions about the population of people with prediabetes, even though a generalizability analysis demonstrated few differences between responders and non-responders to the survey. In addition, demographic profiles between the survey and other studies in those at high risk or with diagnosed prediabetes are similar. For example, Hakkinen et al., [45] also reported high numbers of female responders (75% compared to 73% of our sample), had low numbers of people respond who were normal weight (8% compared to 15% of our sample) and had similar comorbidity profiles (55% with hypertension compared to 59% of our sample, 43% with treated hyperlipidemia compared to 58% of our sample, and 6% reported a heart attack compared to 6% in our sample). While it may be challenging to garner more detailed information from non-responders, future research should make efforts to compare responders to non-responders on other demographic and medical characteristics such as BMI, comorbidities, education, income, and occupational status.

Summary

The Grounded Theory presented provides a guideline to organizations, with similar healthcare contexts and participants, on how to potentially increase the success of a diabetes prevention program. Given the importance of involving the target population in healthcare program design, future healthcare initiatives should consider the value of this theoretical framework when designing their prediabetes program if their setting is similar. However, further research needs to be conducted in community intervention trials to determine if implementation of the suggested recommendations would result in improvements in the effectiveness, cost-effectiveness, practicality, and applicability within prediabetes programs in other healthcare settings.

Figure 3.1. A general model of how prediabetes service provision impacts behavior change

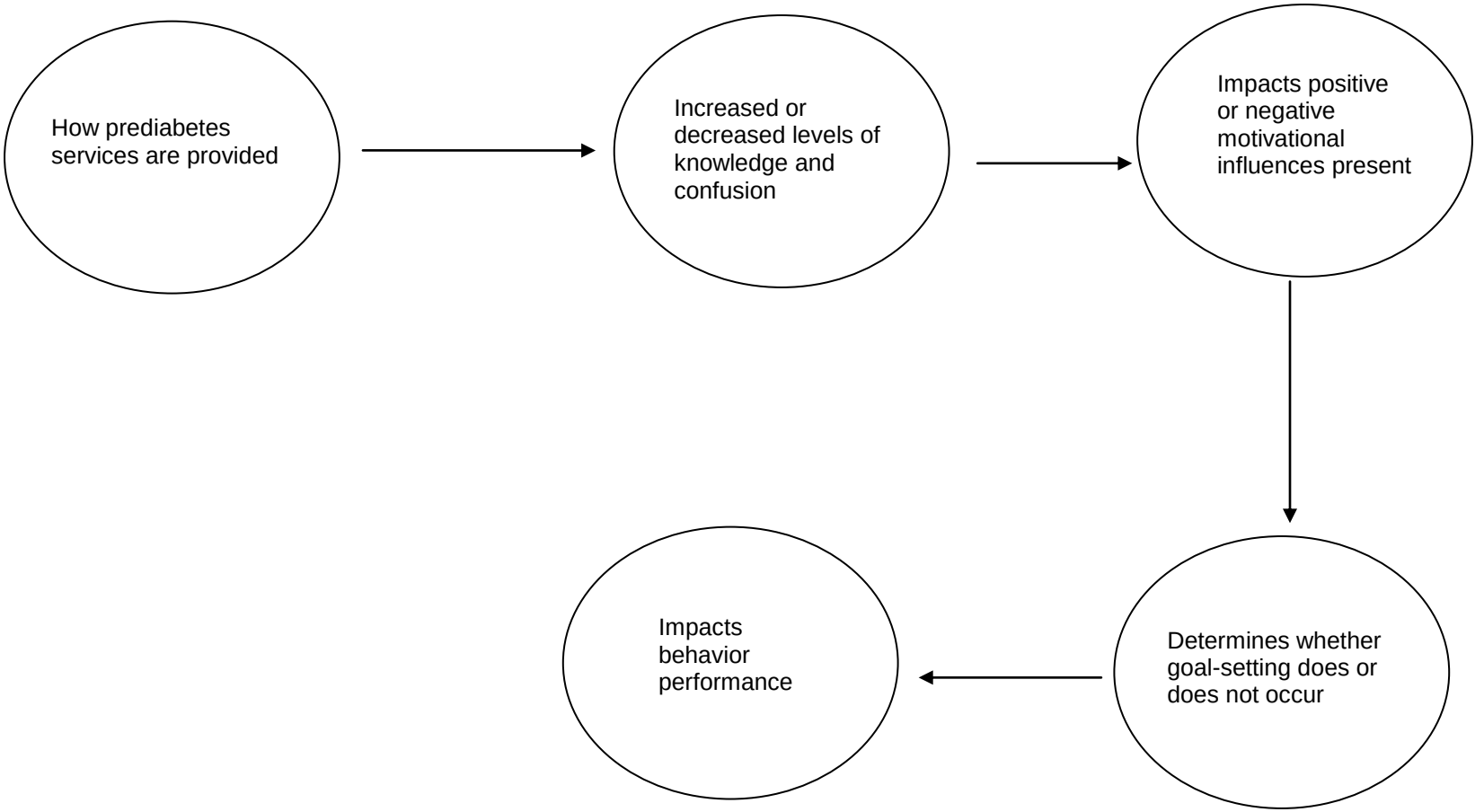

Figure 3.2. A detailed model of how prediabetes service provision impacts behavior change

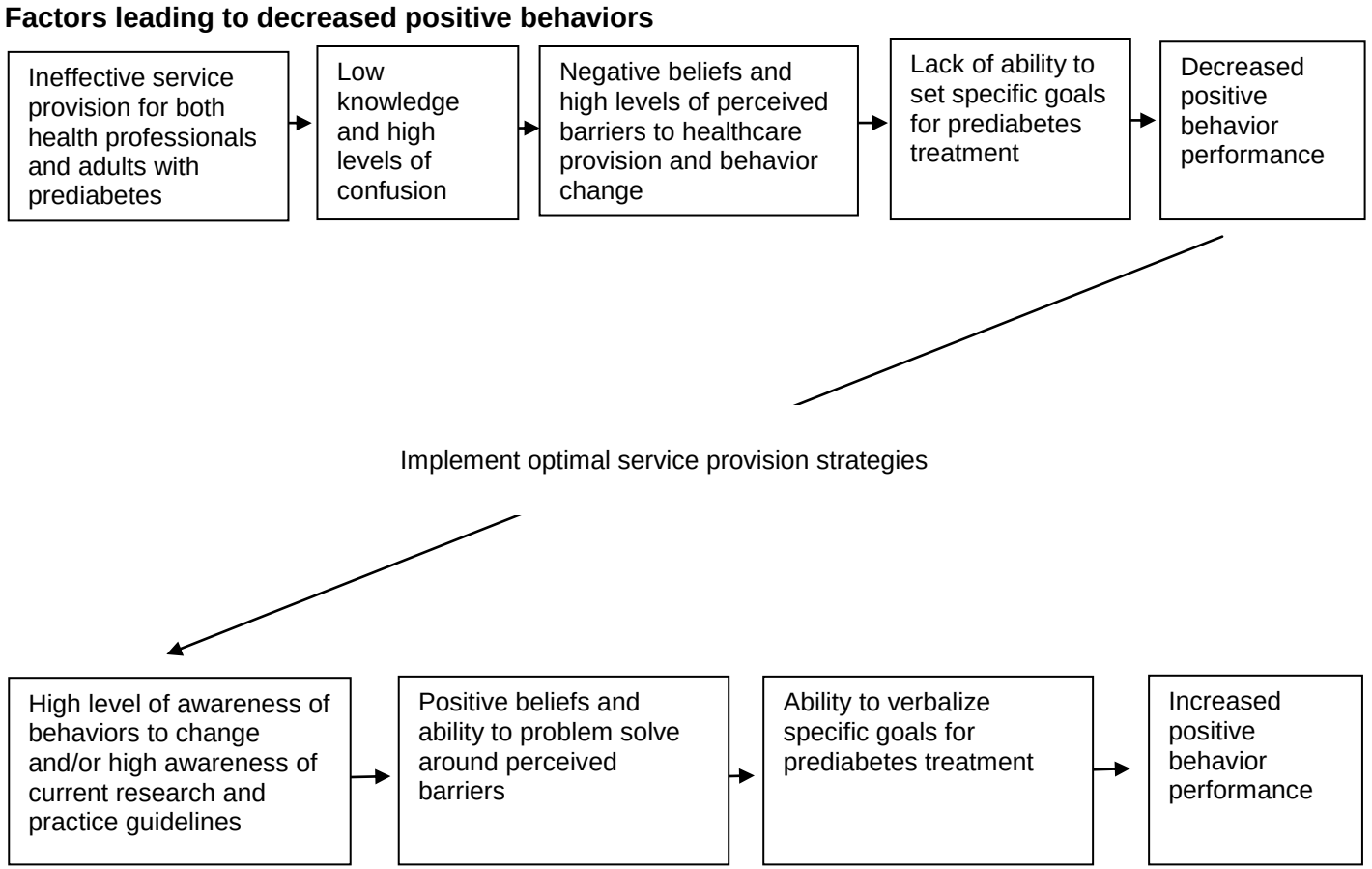

Table 3.1. Program information and program preferences of individuals with prediabetes

Program information*	**n**	**%**
Required a visit to a medical professional in last 12 months for prediabetes (n=230)		
Yes	107	46.5
No	123	53.5
Health professional visits in the last 12 months (n=220)		
Family doctor	145	65.9
Walk-in clinic doctor	7	3.2
Nurse	13	5.9
Dietitian	46	20.9
Endocrinologist	3	1.4
Problems getting medical care for prediabetes in last 12 months (n=227)		
Yes	19	8.4
No	208	91.6
Heard about prediabetes education class from (n=202)		
Family doctor	194	96.0
Friend or family member	4	2.0
Pharmacist	2	1.0
Community health nurse	2	1.0
Want follow-up after attending a prediabetes class (n=227)		
Yes	179	78.9
No	48	21.1
Preference information	**n**	**%**
Preferred modality for education about prediabetes (n=229)		
Internet	95	41.5
Family doctor	114	49.9
Educational DVD	69	30.1
Education class	138	60.3
Preferred day of the week for prediabetes class (n=212)		
Weekday	167	78.8
Weekend	45	21.2
Preferred time of day for prediabetes class (n=211)		
9:00 am to 12:00 pm	115	54.5
1:00 pm to 5:00 pm	58	27.5
6:00 pm to 9:00 pm	38	18.0
Preferred location for prediabetes class (n=222)		
Library	85	38.3
Family doctor’s office	63	28.4
School in community	100	45.0
Hospital	136	61.3

Community health centre	151	68.0
Preferred characteristics of person teaching prediabetes education class (n=230)		
Someone my own age	17	7.4
Someone who gives specific instructions	132	57.4
Someone who is male	2	0.9
Someone who is female	10	4.3
Someone from own culture	18	7.8
A health professional	197	85.7
A trained lay person who has prediabetes	61	26.5
Preferred type of follow-up after attending a prediabetes class (n=213)		
Talking to family doctor	81	38.0
Telephone calls from health professional	86	40.4
Internet education sessions	46	21.6
DVD education sessions	44	20.7
Emails from a health professional	81	38.0
Preferred rate of follow-up (n=163)		
Weekly for the first month then monthly	36	22.1
Monthly for the first 6 months then once every 6 months	95	58.3
Every month	28	17.2
Every 2 weeks	4	2.5

*Note: variables do not equal 232 due to missing data.

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CHAPTER 4:

Study 2: Physical activity and health-related quality of life in individuals with prediabetes

Physical activity and health-related quality of life in individuals with prediabetes

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INTRODUCTION

Prediabetes describes individuals who have impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) [1]. Among adults aged 45 years and older, the prevalence of prediabetes is approximately 25% [2-4]. Evidence suggests moderate PA of at least 150 minutes per week (min/wk), in combination with a 5-10% weight loss, is associated with reducing the risk of developing type 2 diabetes (T2D) and helps to maintain weight loss in those with prediabetes [5-8].

The American Diabetes Association recommends a program of weight management combined with at least 150 min/wk of moderate to vigorous PA for the prevention of T2D [9]. This guideline also reflects current U.S. public health guidelines of achieving a minimum of moderate-intensity PA for 30 minutes on at least five days each week or a minimum of 20 minutes of vigorous-intensity PA on at least three days each week [10]. Despite these guidelines and the wealth of evidence indicating favorable effects of PA on both physical and psychosocial health variables in populations other than prediabetes, little is known about the PA behaviors of individuals with prediabetes. No studies have examined the relationship between physical and mental functioning, including health related quality of life (HRQoL) and meeting or not meeting prediabetes PA guidelines in individuals with prediabetes.

Bize and colleagues [11] report that both cross-sectional and randomized controlled trial studies in a variety of populations consistently indicate positive associations between PA and HRQoL, but report a need for further research in this area. Therefore, the objective of this study was to determine if any differences in HRQoL exist between individuals with prediabetes who are physically active compared to those who are inactive. We hypothesized that

individuals with prediabetes meeting PA guidelines would report higher HRQoL (i.e., physical and mental functioning) than those not meeting PA guidelines.

METHODS

Participants

Participants were 232 individuals with prediabetes living in Alberta, Canada who had registered in a prediabetes education class. To be included in this study, participants had to have a doctor or nurse tell them they had prediabetes, IFG or IGT, be at least 18 years of age, and be able to read English. Ethical clearance to conduct this study was granted by the University of Alberta's Health Research Ethics Board.

Design and Procedures

This study was a cross-sectional survey design. Individuals with prediabetes were recruited via a health region database. All recruitment-related procedures were conducted by the Capital Health Regional Diabetes Program (Alberta, Canada). Surveys were mailed to 1500 randomly selected individuals out of 1911 registered in regional prediabetes education classes from January, 2004 to December, 2007. Individuals were sent an information letter and survey. A second mail-out, consisting of the information letter and survey, was then sent to 750 randomly chosen non-responders four weeks after the first survey was mailed. The survey was conducted in July and August, 2008. The recruitment strategy and survey method used in this study included many features known to increase response/participation rates, including: a personalized cover letter with original as opposed to photocopied signatures, colored paper, assurance of confidentiality, university/institution sponsorship, and one reminder (i.e., follow-up survey if no response) [12].

Of the 1,500 surveys distributed, 1084 were not returned, 97 were returned unopened, and 319 were returned representing a response rate of 23% (319/1403). Of the returned surveys, 25 were not completed, 28 people did not report prediabetes, and 34 people reported having T2D. People not reporting a diagnosis of prediabetes (n = 28) and reporting a diagnosis of T2D (n = 34) were excluded from all analyses; representing a final sample of 232. To examine representativeness, we compared our sample (N = 319) to those who did not respond (N = 1181) on age and gender. In the total sample, there was no difference by age ($p > .05$) but fewer men responded (27%) compared to those who did not respond (35%) ($p < .01$).

Measures

Demographic information was gathered via self-report and included age, gender, marital status, cultural background, education, income, and employment status.

Health information was also gathered via self-report and included height, weight, smoking, the number of months since diagnosis, and comorbidities (i.e., high blood cholesterol, high blood pressure, stroke, angina and heart attack). Body mass index (BMI) was calculated from self-report height and weight according to national guidelines [13]. Specifically, a BMI of 30 or higher was classified as obese, a BMI less than 30 but greater than 25 was classified as overweight and a BMI less than or equal to 25 was classified as normal weight.

Physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [14]. The GLTEQ was modified to include the average duration of each PA session reported for each different level of intensity (i.e., mild, moderate, vigorous). Examples of vigorous activities included aerobics classes, jogging, swimming laps, hard bicycling, singles tennis, and soccer.

Examples of moderate activities included brisk walking, doubles tennis, easy bicycling, pilates, yoga, easy swimming, popular and folk dancing, and golf without a cart. Finally, examples of light intensity activities included easy walking, bowling, lawn bowling, shuffleboard, and golf with a cart. Weekly minutes were calculated by multiplying the frequency of both moderate and vigorous PA by the duration in minutes, respectively. Participants' weekly minutes in moderate- and vigorous-intensity PA were multiplied by 4.0 METS for moderate activity and 7.5 METS for vigorous activity to create MET.minutes (MET.min) [15]. Weekly MET.min of moderate and vigorous activity were summed to create total weekly MET.min. Participants were categorized as "active" if they achieved ≥ 600 MET.min per week or "inactive" if they achieved less [15]. An independent evaluation of the GLTEQ found its reliability to compare favorably to nine other self-report measures of exercise based on test-retest scores, objective activity monitors and fitness indices [16].

Health-related quality of life was assessed using the four-week version of the RAND-12 Health Status Inventory (RAND-12) [17-18]. The RAND-12 gives two scores reflecting both physical and mental health; a mental (MHC) and physical health composite (PHC) of six items each. Scoring the RAND-12 requires a) item response option weights, b) PHC and MHC intercept values, and c) age-based parameter estimates, all found in the scoring manual [17]. T-scores ≤ 42 on the PHC and ≤ 38 on the MHC represent either physical health problems likely to impede life function or people who likely experience symptoms of depression and/or anxiety, respectively [17]. People reporting a T-score > 53 on the PHC or MHC are less likely to report any physical or mental health symptoms that impede their life function [17].

Statistical Analyses

Data were entered into SPSS 17.0 for Windows (Chicago, IL, USA). Descriptive statistics were calculated for demographic and health characteristics, the proportion of individuals meeting prediabetes PA guidelines, and those above and below the PHC and MHC cut-off values. For the primary analyses, self-reported PA behavior was coded as 0 (not meeting PA guidelines) and 1 (meeting PA guidelines). Multivariate analysis of covariance (MANCOVA) procedures were used to test differences in HRQoL (i.e., PHC, MHC) between participants meeting and not meeting PA guidelines. Covariates in the model included BMI, age, income, smoking and gender. These covariates had statistically significant correlations with either the PHC or the MHC scales. A significant MANCOVA was followed by univariate F-tests for each specific HRQoL composite scale. Linear independent pairwise comparisons were analyzed to examine the magnitude of the differences in the mean scores of the dependent variables. Effect sizes (*d*) were computed by dividing the differences in means between groups by the pooled SD and are interpreted as small (d = 0.20), medium (d = 0.50), or large (d = 0.80) [19].

RESULTS

Demographic and health characteristics are shown in Table 4.1. Briefly, the mean (SD) age of our sample was 58 (11.0) years, 73% were female, 72% were married or common-law, 88% reported descending from a Caucasian cultural background, 35% completed university/college, 40% had a family income >$80000, and 53% were currently working full or part-time. Approximately 59% were classified as obese (i.e., BMI ≥ 30), 89% reported no smoking, and about 59% reported having high blood cholesterol and/or high blood pressure. The median number of months since diagnosis was 31 months or 2.6 years.

Descriptive statistics for PA and HRQoL are shown in Table 4.2. Overall, 38% (n = 88) of our sample of individuals with prediabetes were achieving PA guidelines. The PHC scale had a mean *T*-score of 46.6 (SD = 9.9) and the MHC a mean *T*-score of 45.2 (SD = 9.7).

Table 4.3 displays the bivariate correlations among PA, HRQoL, age, BMI, income, smoking and the comorbidity index. Significant correlations were present between the PHC and strenuous and moderate MET.min/wk ($r = .21$, $p < .01$ and $r = .22$, $p < .01$ respectively), total MET.min/wk ($r = .29$, $p < .01$), age ($r = .15$, $p < .05$), BMI ($r = -.40$, $p < .01$), income ($r = .26$, $p < .01$), and smoking ($r = -.17$, $p < .05$). Significant correlations were present between the MHC and moderate MET.min/wk ($r = .14$, $p < .05$), total MET.min/wk ($r = .18$, $p < .01$), BMI ($r = -.18$, $p < .01$), income ($r = .22$, $p < .01$), and smoking ($r = -.18$, $p < .01$).

With HRQoL (i.e., PHC, MHC) entered as the dependent variables and meeting PA guidelines entered as the independent variable (i.e., 0 = <600 total MET.min/wk; 1 = $\geq$600 total MET.min/wk), the overall MANOVA was significant [Wilks' $\lambda = 0.926$, $F(2,229) = 9.148$, $p < .001$]. Follow-up univariate F-statistics indicated significant differences for both PHC ($F = 14.81$, $p < .001$) and MHC ($F = 12.91$, $p < .001$). Linear independent pairwise comparisons indicated those participants achieving PA guidelines reported significantly higher scores on the PHC ($M_{diff} = 5.0$, $p < .05$, ES = .51), and MHC scales ($M_{diff} = 4.6$, $p < .05$, ES = .47) than those not achieving PA guidelines.

We repeated the analysis using MANCOVA procedures covarying on age, BMI, income, smoking and gender (See Table 4.4). Results were similar to the original MANOVA model. Specifically, the overall omnibus statistics remained significant [Wilks' $\lambda = 0.967$, $F(2,224) = 3.791$, $p < .05$]. Income and smoking were significant covariates in the model for both PHC and MHC. Gender, BMI

and age were significant covariates in the model for PHC. Our interpretation of the MANCOVA results were similar to the MANOVA model. With the covariates entered in the model, linear independent pairwise comparisons indicated those achieving PA guidelines still reported significantly higher scores on PHC (M_{diff} = 2.7, $p < .05$, ES = .27) and MHC (M_{diff} = 3.0, $p < .05$, ES = .31) than those not achieving PA guidelines.

DISCUSSION

In support of our hypotheses, we report individuals with prediabetes who are physically active have significantly higher mean scores on PHC and MHC compared to inactive individuals with prediabetes. These results demonstrate meeting PA guidelines is associated with better physical and mental life functioning among our sample of people with prediabetes. Future intervention trials should explore the effect of PA on HRQoL in those with prediabetes.

We report only 38% of participants were achieving PA guidelines. The Finnish Diabetes Prevention Study (DPS) and the American Diabetes Prevention Program (DPP) report baseline leisure-time PA minutes via a validated self-report PA questionnaire [5, 20]. In the DPS, at least 50% of the participants in both the control and intervention groups were considered physically active using current PA guidelines [20]. In the DPP, baseline intervention group median leisure–time PA was 534 MET.min/week [21]. The levels of PA reported in these studies are higher than the MET values demonstrated in our study (i.e., median = 240 MET.min/wk)

It is also worthwhile to compare the PA levels observed in our study to those of the general population. Recent estimates of Albertans living in the Edmonton/Capital Health Region indicate 55.7% of 45-54 year olds, 48.0% of 55–64 year olds and 36.9% in ≥ 65 year olds are considered physically active

[22]. These overall estimates are similar to baseline DPS (mean age = 55 years) and DPP (mean age = 51 years) data on individuals with prediabetes, but higher than what is reflected in our study (i.e., 38% with a mean age = 58 years). In comparison to the general Albertan population, the lower level of PA observed in our study is likely due to the nature of our sample which is heavier (i.e., mean BMI = 31), older, includes a greater proportion of females, and has higher levels of comorbidities.

The results reported in this study provide evidence for differences in HRQoL among our sample of individuals with prediabetes compared to the general population. In our sample, 31.6% reported a low score on the PHC compared to U.S. normative sample data of 19.8% reporting a low score [17]. On the PHC, 30.5% reported a high score in our sample and 45.8% of the U.S. sample [17]. For the MHC, in our sample, 27.1% scored low while 14.4% of the U.S. sample scored low [17]. A high score on the MHC was obtained by 22.6% of our sample while 46.8% of the U.S. sample scored high [17]. Thus, physical and mental health functioning appear to be impaired in our sample of individuals with prediabetes compared to a U.S. normative sample. Further evidence for this distinction has been provided by studies on HRQoL in people with prediabetes compared to people with normal glucose tolerance (NGT).

The AusDiab study identified that individuals with IGT (N = 1264) were more likely to be in the lowest quartile of the SF-36 on the physical (adjusted OR = 1.44, 95%CI = 1.14-1.81) and social (adjusted OR = 1.46, 95%CI = 1.20-1.77) functioning scales compared to those with NGT [23]. Another study also reported people with IFG demonstrated significant impairment on the physical functioning and bodily pain scales of the SF-36 and significantly lower mean scores on both the physical component score (PCS) (*M* = 43.2, SE = 0.8) and the mental

component score (MCS) (*M* = 50.5, SE = 0.8) compared to people with NGT [24]. These reports suggest individuals with prediabetes may receive HRQoL benefits from PA-related interventions. Future randomized controlled trials may benefit from examining this contention.

Though no other studies have examined PA and HRQoL in individuals with prediabetes, Hakkinen and colleagues [25] have examined PA and HRQoL in those at '*high risk*' of developing T2D. This study identified that individuals who engaged in PA two or more times per week had better perceived general health and physical functioning compared to those not engaging in PA. In addition, as PA frequency decreased, HRQoL also significantly decreased across all eight dimensions of the SF-36. Lee et al., [26] also identified higher scores on the PCS in overweight and obese individuals who were in an action stage of change for exercise compared to those in a precontemplation stage; no significant differences were observed on the MCS. While our results and the results from these studies provide evidence of a positive association between HRQoL and PA in individuals with prediabetes, further studies need to explore the specific PA modality, timing, and intensity that may be associated with any potential HRQoL benefit.

Study Limitations and Strengths

Our study has several strengths worth noting including the use of validated scales for PA and HRQoL, the survey protocol, and the inclusion criteria that participants needed to be diagnosed with prediabetes. Another major strength was the adherence to prediabetes PA recommendations of engaging in ≥ 600 MET.min/wk. Despite these study strengths, the limitations must be acknowledged when interpreting the results. First, despite our generalizability analysis suggesting no differences in various demographic variables between

responders and non-responders, our low response rate nonetheless limits the ability to draw conclusions about the population with prediabetes. However, demographic profiles between our study and other studies in those at high risk or with diagnosed prediabetes are similar. For example, the Hakkinen study [25] also reported a high number of female responders (75% compared to 73% of our sample), had a low number of people respond who were normal weight (8% compared to 15% of our sample) and similar comorbidity profiles (55% with hypertension compared to 59% of our sample, 43% with treated hyperlipidemia compared to 58% of our sample, and 6% reported a heart attack compared to 6% in our sample). In addition, the average BMI (31.2, SD = 6.4) in our sample is similar to those reported in both the DPS (31.3, SD = 4.5) and the DPP (34, SD = 6.7) [20, 27]. While it may be challenging to garner more detailed information from non-responders, future research should make efforts to compare responders to non-responders on other demographic and medical characteristics such as BMI, comorbidities, education, income, and occupational status.

Second, the causal order of PA and HRQoL cannot be determined given the cross-sectional design. Previous research has demonstrated the difficulty in establishing the direction of the association between PA and HRQoL. For instance, according to a recent review examining the relationship between PA and HRQoL, people who are active generally have higher quality of life levels, but the results of randomized controlled trials, while favorable, have not been conclusive [11]. Future studies need to conduct both longitudinal and randomized controlled trial designs to garner a deeper understanding of the relationship between PA and HRQoL. Finally, as with all research based on self-report measures of PA and body weight there are inherent limitations such as recall bias and social desirability. Future research should use objective or direct

measures of PA (e.g., accelerometers, pedometers) and health indices (e.g., measured body weight and height).

In summary, individuals achieving PA guidelines reported higher physical and mental HRQoL scores compared to those not achieving PA guidelines. Approximately 38% of the sample was achieving prediabetes PA guidelines. Given the results of this investigation, randomized controlled trials (e.g., efficacy trials, behavior change trials) may benefit from examining the effects of regular and sustained PA on HRQoL and psychosocial health outcomes in individuals with prediabetes. In addition, motivation and adherence continue to be important issues when implementing PA programs for adults in general. Therefore, future research should examine psychosocial, policy and environmental determinants of PA to gain a better understanding of how to assist individuals with prediabetes to adopt regular moderate- to vigorous-intensity PA.

Table 4.1. Demographic and health characteristics[†]

Characteristic	No. of Respondents	%	Mean (SD)
Age (years)	232		58.1 (11.0)
Female gender	232	73.3	
Marital Status	231		
Married/Common Law	168	72.4	
Divorced/Separated	21	9.5	
Widowed	15	6.5	
Never Married	27	11.6	
Cultural Background	230		
Caucasian	203	88.3	
Chinese or Asian	10	4.3	
Aboriginal	11	4.8	
Other	6	3.5	
Education	230		
Some High School	27	11.7	
Completed High School	57	24.8	
Some University/College	44	19.1	
Completed University/College	80	34.8	
Some Graduate School	12	5.2	
Completed Graduate School	10	4.3	
Annual Family Income	201		
<$20,000	16	8.0	
$20,000-$39,999	40	20.1	
$40,000-$59,999	34	17.1	
$60,000-$79,999	29	14.6	
>$80,000	80	40.2	
Employment Status	229		

Retired	80	34.9	
Disability	16	7.0	
Employed Full/Part-Time	121	52.8	
Temporarily Unemployed	5	2.1	
Homemaker	7	3.1	
Body Mass Index (kg/m^2)	232		31.2 (6.4)
Normal Weight (BMI<25)	34	14.7	
Overweight (BMI≥25 – 29.9)	62	26.7	
Obese (BMI≥30)	136	58.6	
Smoking	232		
Not at all	206	88.8	
Occasionally or daily	26	11.2	
Months Since Diagnosis	232	Median (IQR)	31.0 (22.3 – 42.5)
Comorbidities	232		
High Blood Cholesterol	134	57.8	
High Blood Pressure	137	59.1	
Stroke	10	4.3	
Angina	22	9.5	
Heart Attack	13	5.6	

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† Numbers may not equal 232 due to missing data, study conducted in Edmonton, Alberta in August-September, 2008.

Data are presented as the mean (standard deviation) for continuous variables and frequency (percentage) for categorical variables.

Table 4.2. Descriptive statistics for study participants' physical activity behaviors and health-related quality of life

Variable	%	Mean/Median	SD/(Interquartile range)
% Achieving PA Guidelines†	37.9		
Weekly Physical Activity METS			
Strenuous MET.minutes		232.1/0.0	550.1/(0.0-0.0)
Moderate MET.minutes		373.9/80.0	615.1/(0.0-530.0)
Mild MET.minutes		377.1/75.0	1030.5/(0.0-350.0)
Total Moderate + Strenuous MET.minutes		606.0/240.0	852.8/(0-975.0)
Quality of Life			
PHC (0-100)		46.6	9.9
MHC (0-100)		45.2	9.7
% Achieving low T-score*			
PHC (≤42)	31.6%		
MHC (≤38)	27.1%		
% Achieving high T-score*			
PHC (>53)	30.5%		
MHC (>53)	22.6%		

N=232, study conducted in Edmonton, Alberta in August-September, 2008.
Data are presented as the mean ± standard deviation for continuous variables and frequency % for categorical variables.
PHC = Physical Health Composite Score, MHC = Mental Health Composite Score.

†(Brown and Bauman, 2000)

*(Hays, 1998)

Table 4.3. Bivariate Pearson product-moment correlations among mean PA indices, HRQoL, demographic and health characteristics

Variable	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Strenuous MET.min	.07	.08	.69**	.21**	.12	-.06	-.08	.02	-.10	-.01
2. Moderate MET.min		.11	.77**	.22**	.14*	.15*	-.19**	.13*	-.13*	-.04
3. Mild MET.min			.13*	-.05	-.08	-.06	.04	-.14*	.04	-.06
4. Total MET.min				.29**	.18**	.07	-.19**	.11	-.16*	-.04
5. Physical Health Scale					.54**	.15*	-.40**	.26**	-.17*	-.05
6. Mental Health Scale						.10	-.18**	.22**	-.18**	.03
7. Age (years)							-.20**	-.30**	-.06	.41**
8. BMI (kg/m^2)								-.05	.05	-.00
9. Income									.04	-.14*
10. Smoking										.11
11. Comorbidity index[†]										

Study conducted in Edmonton, Alberta in August-September, 2008.

Note. *p < .05, **p < .01.

[†] A comorbidity index was created to reflect the number of different comorbidities participants indicated they had (i.e., high blood cholesterol, previous angina, previous heart attack, high blood cholesterol, previous stroke). Given we assessed the prevalence of 5 comorbidities, the comorbidity index ranged from 0 (i.e., no reported comorbidities) to 5 (i.e., all 5 comorbidities were present).

Table 4.4. Health related quality of life in individuals with prediabetes meeting PA guidelines and those not meeting guidelines

Variable	Meeting PA Guidelines (n=88)		Not Meeting PA Guidelines (n=144)		Difference			
	M	SD	M	SD	M	SE	*d*	P
PHC	49.7	9.2	44.7	9.9	2.7	1.18	.27	<.05
MHC	48.1	9.3	43.5	9.6	3.0	1.27	.31	<.05

N=232, study conducted in Edmonton, Alberta in August-September, 2008.

Note: data presented are adjusted for income, smoking, age, BMI, and gender (i.e., MANCOVA).
Data are presented as the mean (standard deviation).
PHC = Physical Composite Score, MHC = Mental Composite Score.
ES (*d*) = Mean difference / pooled SD.

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Chapter 5:

Study 3: Physical activity programming and counseling preferences among individuals with prediabetes

Physical activity programming and counseling preferences among individuals with prediabetes

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INTRODUCTION

Prediabetes diagnosis includes impaired fasting glucose (IFG) defined by a fasting plasma glucose (FPG) ranging from 110 to 124 mg/dl (6.1-6.9 mmol/l) and a 2-hour plasma glucose less than 140 mg/dl (7.8 mmol/l) or impaired glucose tolerance (IGT) defined as a FPG greater than 110 mg/dl (6.1 mmol/l) and a 2hPG of 140-198 mg/dl (7.8-11.0 mmol/l) [1]. Among adults aged 40 years and older the prevalence of diagnosed prediabetes ranges from approximately 25%-40% in the United States (U.S.), 15%-34% in Denmark and 17-30% in Australia [2-5]. Increases in type 2 diabetes (T2D) risk are largely due to increasing levels of overweight, obesity and physical inactivity [6].

Evidence suggests that moderate-intensity PA of at least 150 minutes per week, in combination with modest weight loss, is associated with reducing the risk of developing T2D and helps to maintain weight loss among those with prediabetes [7-11]. Furthermore, because dyslipidemia and hypertension are common [2] among individuals with prediabetes and because participation in regular PA is associated with improved cardiovascular health [12], increasing participation in regular moderate-intensity PA has the potential to improve physical health in this population [10]. As a result, current prediabetes guidelines recommend a 5-10% weight loss combined with at least 150 minutes/wk of moderate- to vigorous-intensity PA for the prevention of T2D [11, 13]. Current U.S. public health guidelines for PA are similar and recommend at least 30 minutes of moderate-intensity PA on at least five days each week or at least 20 minutes of vigorous-intensity PA on at least three days each week [12]. Despite these guidelines, the majority of individuals with prediabetes may not be engaging in 150 minutes/wk of moderate- to vigorous-intensity PA to gain health

benefits. For instance, only 54.7% of people in the U.S. with prediabetes attempted to increase their PA or exercise over a 12-month period [14].

Designing and implementing PA programs for individuals with prediabetes requires a better understanding of potential mediating and moderating influences. More exploration is needed on how health (e.g., health-related quality of life), demographics, environmental and cognitive determinants influence PA participation in people with prediabetes. In addition, examining PA preferences and factors related to PA preferences can facilitate the initiation and maintenance of PA [15], and aid clinicians and program planners to develop intervention tools, programs and strategies that appeal to individuals with prediabetes and encourage participation and engagement [16]. Utilizing this knowledge may add to the PA recommendation knowledge base as well as tailoring PA interventions designed for individuals with prediabetes [17].

To our knowledge, no studies have examined the preferences of PA among the prediabetes population. However, two studies examining preferences for PA in adults with T2D identified walking and gardening as the most preferred forms of PA [18-19]. Thompson and Wankel [20] found that females enrolled in a private health club assigned to aerobic classes congruent with their PA preferences demonstrated better attendance and had stronger intentions to continue participating in the PA class than participants assigned to a generic PA class. As Wilcox et al. [17] indicate, when planning a PA intervention program, it is useful to tailor the intervention to the preferences of individuals, as this is likely to increase the adoption and maintenance of PA.

Therefore, the primary objective of this study was to identify the PA preferences in a sample of individuals with prediabetes. The second purpose was

to determine whether various demographic, health and PA variables influence individuals' PA preferences.

METHODS

Sample

Participants included individuals living in Alberta, Canada who were at least 18 years of age, had a fixed address, were able to read English and reported that a doctor or nurse had told them they had prediabetes, IFG or IGT. The design and procedures of this study are presented in detail elsewhere [21]. Here we provide a brief summary. Ethical clearance to conduct this study was granted by the University of Alberta's Health Research Ethics Board. This study was a cross-sectional survey design. Survey packages were sent to people who had registered in a prediabetes education class. Survey packages were mailed in July, 2008, with a second survey package sent to non-responders 3 weeks later. Informed consent was implied by return of the survey and the final response rate was 17%. In a generalizability analysis, we found few meaningful demographic differences existed between those who participated and did not participate in the survey. There was no difference between those who did and did not participate in age ($p > .05$). However, fewer men responded ($p < .01$) to the survey (27%) compared to those who did not respond (35%).

Measures

Demographic information was collected and dichotomized based on classification or on the mean or median of the sample. Demographic variables included age (i.e., < 60 years and ≥ 60 years), gender, marital status (i.e., no partner and has a partner), ethnicity (i.e., Caucasian or not Caucasian), income (i.e., < $59,999/year and ≥ $60,000/year), employment status (i.e., working and not working), and education (i.e., no university completed and completed

university). Mean imputation based on age and gender, where appropriate, was used for age (0.8% missing data), BMI (6% missing data), and income (13% missing).

Health information included height, weight, co-morbidities (i.e., angina, heart attack, stroke, high blood pressure, high blood cholesterol were dichotomized into no reported comorbidities and ≥ 1 comorbidity) and months since diagnosis (i.e., < 31 months since diagnosis and ≥ 31 months since diagnosis). Body mass index (BMI) was calculated based upon self-reported height and weight and categorized according to national guidelines [22]. Specifically, a BMI of 30 or higher was classified as obese, and a BMI less than 30 was classified as not obese.

Physical activity was measured with the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [23]. The GLTEQ contains three questions that assess the frequency of mild (minimal effort, no sweating), moderate (not exhausting, light sweating), and strenuous (heart beats rapidly, sweating) PA during participants' free time, for 10 or more minutes, in an average week over the past month. The GLTEQ was modified to include the average duration of each PA session reported for each different level of intensity. Weekly minutes were calculated by multiplying the frequency in minutes of both moderate and vigorous PA by the duration in minutes respectively. To provide additional weight for participating in vigorous activity, participants' weekly minutes in moderate- and vigorous-intensity PA were then multiplied by 4.0 METS for moderate activity and 7.5 METS for vigorous activity to create MET.minutes [24]. Weekly MET.minutes (MET.min) of moderate and vigorous activity were then summed to create total weekly MET.min. Participants were categorized as "active" or "meeting guidelines" if they achieved ≥ 600 MET.min per week or "inactive" or "not meeting

guidelines" if they achieved less [24]. A MET.min value of 600 is equal to achieving 150 minutes of moderate-intensity PA or 80 minutes of vigorous-intensity activity each week and is consistent with current public health PA guidelines [24].

Physical activity program preferences were assessed using 10 multiple choice questions and one open-ended question that have been used in previous research [25]. Participants were asked to indicate whether they "would like to be counseled about PA at some point" (i.e., yes, no, maybe); whether they were "physically able to participate in a PA program designed for people with prediabetes" (i.e., yes, no, maybe), and; if they "would be interested in a physical activity program designed for persons with prediabetes" (i.e., yes, no, maybe). With respect to PA program preferences, participants were asked to indicate their preference for companionship (i.e., alone or with other people with prediabetes), location (e.g., at home, at a hospital program), time of day (e.g., morning, night), intensity (i.e., low, moderate, or high), variability (e.g., same activity, different activity), supervision (i.e., supervised or self-paced), and structure (i.e., spontaneous or scheduled). Participants were further asked to indicate whether they were able to participate in a PA program designed for persons with prediabetes (i.e., yes, no, maybe), and whether they would be interested in a PA program designed for persons with prediabetes (i.e., yes, no, maybe).

Statistical Analyses

Data were initially screened for discrepant responses and missing data and entered into SPSS 17.0 for Windows (Chicago, IL, USA). All demographic, health and PA variables were dichotomized. Information regarding these variables and cut-points are detailed in Table 5.1. Chi-square tests for independence were conducted to determine what variables (i.e., demographic,

health and PA) had statistically significant associations with each PA preference variable. Statistical significance was set at $P \leq 0.05$. Variables that had statistically significant associations were further examined using direct logistic regression analysis. One logistic regression model was generated for each preference variable (e.g., ability, interest). In these analyses, odds ratios (OR) as well as the associated 95% CI and corresponding *p*-value are presented. For all logistic regression models, odds ratios reflect the increase (or decrease if the ratio is less than one) in odds of being in one outcome category when the value of the predictor increases by one unit [26].

Dichotomous categories were created for the PA preference items. Specifically, for counseling and interest, the "yes" and "maybe" responses were combined versus "no"; companionship was recoded as "alone" or "with others"; location was recoded as "home" or "not at home"; time of day was recoded as "during day" or "during evening" and intensity was recoded as "low-intensity" or moderate- to vigorous-intensity". Respondents who chose "no preference" on any PA preference item were not included in the logistic regression analyses.

RESULTS

Participant Characteristics

Demographic, health and PA information for the sample are presented in Table 5.1. Briefly, 57% of our sample was below 60 years of age, 73% were female, 73% were married or common-law, 44% completed university/college, 55% had a family income >$60,000, 56% were currently working full, part-time or as a homemaker and 88% were Caucasian. Almost 82% of participants had more than one comorbidity and 50% had been diagnosed with prediabetes for more than 31 months (i.e., 2.6 years). Thirty-eight percent (*n*=88) of the sample were achieving PA guidelines (i.e., achieving ≥ 600 MET.min/wk).

Physical Activity Preferences

Information regarding participants PA preferences is located in Table 5.2. Overall, 74.5% of individuals indicated (i.e., yes or maybe) they would like to be counseled about PA. Furthermore, 95.6% of individuals responded they were physically able to participate in a PA program for people with prediabetes. Another 85.6% of the sample reported interest in a PA program for individuals with prediabetes. Approximately 25% of individuals preferred to engage in PA alone while 42.5% preferred to do PA with someone else (i.e., 19.5% with other people with prediabetes, 15.2% with friends and 7.8% with family). There was no obvious preference for being physically active at home (33.2%), or away from home (33.6%); although only 5.3% wanted to engage in PA at a hospital-based program. The majority of individuals with prediabetes indicated they would prefer to engage in PA during the day (54.1%); at a moderate- or vigorous-intensity level (80.0%); engage in different activities each PA session (73.3%); be supervised and instructed (60.6%); and engage in their PA at scheduled times and days (71.2%). Further inquiry into specific PA preferences revealed the majority of individuals would be most interested in walking (70.7%). Sports-related activities, like golf, dance, squash, badminton and hockey as well as swimming were the second most commonly preferred activity (31.5%). Figure 5.1 lists study participants preferred physical activity modalities.

Associations between demographic, health, and PA variables and PA preferences

After the chi-squared analyses were completed, physical activity preference items including ability, variability and supervision did not demonstrate any significant associations with any demographic, health or physical activity variables. As depicted in Table 5.3, people who were meeting PA guidelines

were less likely to want PA counseling (OR = 0.51, 95% CI = 0.28-0.95) and less interested in a PA program targeted to people with prediabetes (OR=0.42, 95% CI= 0.20-0.89) than people who were not meeting PA guidelines. In addition, people who were meeting guidelines were more likely to report wanting to be active alone (OR = 2.12, 95% = 1.05-4.29), and at a higher intensity (OR = 4.06, 95% CI = 1.15-14.30) than individuals not meeting guidelines. People who were employed were also more likely to want to be active alone (OR = 2.12, 95% CI = 1.05-4.29) and people who had more than one comorbidity were less likely to want PA counseling (OR = 0.37, 95% CI = 0.14-0.99). Individuals who had been diagnosed with prediabetes for more than 31 months were more likely to want scheduled PA sessions (OR = 2.30, 95% CI = 1.25-4.21) than people who had not been diagnosed as long. Individuals who were married or common-law were more likely to want to be physically active at home versus out of the home (OR = 2.47, 95% CI = 1.19-5.13). Individuals who had a BMI over 30 (OR = 3.40, 95% CI = 1.58-7.33) or were employed (OR = 4.63, 95% CI = 1.83-11.72 respectively) were more likely to want to be physically active during the evening than during the day.

DISCUSSION AND CONCLUSIONS

Discussion

The primary objective of this study was to identify the PA preferences in a sample of individuals with prediabetes. The second purpose was to determine whether various demographic, health, and PA variables were associated with individuals' PA preferences for mode of activity and counseling strategies. We reported the majority of individuals with prediabetes would like to receive PA counseling, were able to participate in a PA program, and were interested in

participating in PA programs for individuals with prediabetes. We also report various demographic (i.e. marital status, BMI, employment), health (i.e., comorbidities, months since diagnosis) and PA characteristics (i.e., those meeting and not meeting guidelines) are associated with specific PA preferences in this sample of individuals with prediabetes. Most individuals surveyed indicated walking (71%) as their preferred source of activity. This information may be used by researchers, PA programmers, and clinicians to develop targeted PA programs for individuals with prediabetes. Ultimately, developing programs and interventions that appeal to individuals with prediabetes may encourage participation and sustained engagement in PA [16].

Respondents indicated several unique programming preferences for PA, as well as preferences that are concurrent with PA preferences that have been elicited from other populations (e.g., cancer survivors) [27]. For example, Karvinen et al. [27] reported bladder cancer survivors were largely interested (81%) and able (84%) to participate in a PA program. Similar data has been reported in other survivor groups such as non-Hodgkin's lymphoma [25], ovarian cancer [28], and breast cancer [29]. We found that 75% of individuals with prediabetes indicated they would like to be counseled about PA and 96% indicated that they would be physically able to participate in a PA program. While the majority of participants would like counseling related to PA, clearly a substantial proportion (i.e., 26%) do not have a desire to participate in strategies designed to facilitate their PA, a cornerstone of treatment for the prevention of T2D. Similar to these results, in a survey of 984 people with self-reported prediabetes in the U.S., approximately 24% were not participating in any preventive behaviors for T2D (i.e., did not engage in physical activity, try to lose weight, or reduced dietary fat/calories in the last 12 months) [14]. This highlights

a major challenge when promoting PA (and other health-related behaviors) in this population. Stevinson and colleagues [28] recently suggested some individuals may be unaware, or not convinced of the health-related benefits associated with a physically active lifestyle. Unfortunately, there are few published reports of PA preferences from population sub-groups other than cancer. Information related to the PA preferences of various subpopulation (e.g., prediabetes, T2D, older adults, overweight/obese), such as the PA preferences identified in this study, should be elicited. This has the potential to garner a better understanding of PA motives, and target PA interventions and programs to the needs and preferences of the population under examination.

To the best of our knowledge, this is the first study to describe PA preferences in individuals with prediabetes. Perhaps most closely related to our study is a report by Wanko et al. [18] exploring the exercise preferences of urban African Americans with T2D (n=605). Wanko and colleagues reported the majority of individuals with T2D preferred walking outdoors (74%), followed by gardening (28%), bicycling (17%), sports/athletics (16%), and swimming (15%). Another study of exercise preferences in people with T2D identified the majority preferred gardening (34.8%), walking (31.3%), calisthenics (12.0%) and biking (9.2%) [19]. The majority of individuals in our study also indicated they would be most interested in walking (71%), followed by sport-related activities (31.5%), swimming (31.5%), resistance training (22.9%), and cycling (20.3%). Clearly, there are similarities in the preferred activities between these two populations. The finding that the majority of individuals preferred walking is encouraging given the large evidence-base indicating moderate-intensity activities (e.g., brisk walking) in the prevention of T2D. Indeed, the American College of Sports Medicine [30] has suggested the PA programs should emphasize activities such

as walking, given the health-related benefits associated with walking, and ease of access in which these types of activities can be performed.

We found several unique associations between various demographic, health and PA variables and individuals' PA preferences. In particular, we report individuals with prediabetes who were meeting PA guidelines and who had one or more comorbidities were 49% and 63% less likely to want PA counseling than those who were not meeting PA guidelines or who had no comorbidities respectively. Also, active individuals were 58% less likely to be interested in participating in a PA program for individuals with prediabetes. We were unable to locate corroborative findings in previously published PA preference research. Nonetheless, these findings suggest individuals with prediabetes who are already active are satisfied with their PA and prefer to continue the PA they have already been doing successfully. This seems logical when inactive individuals report they are more likely to want PA counseling and have a greater interest in PA programs as they may be in pursuit of advice, or a PA program to facilitate their engagement in PA and/or other health-related activities. Active individuals were also more likely to prefer to be active alone (versus with others) when compared to inactive individuals. It was surprising that people with one or more comorbidities were less likely to want PA counseling. In a previous paper [21], we reported no significant relationship between self-rated physical health quality of life or the amount of time spent participating in PA and the number of reported comorbidities. In addition, we report in this study that people with one or more comorbidities do not see themselves as less able to participate in a PA program than those with no comorbidities. A qualitative analysis in people with prediabetes identified that people with more than one chronic condition (e.g., hypertension and prediabetes) often feel confused about competing advice they

have been given about behavior change [31] and this study suggests this sample of individuals with one or more comorbidities did not want any more PA advice. Future research should explore whether the number of comorbidities a person has influences their cognitions and explore how this influences participation in PA.

It is interesting to note that we did not find an association between age and the preference to be active either alone or in a group context. Previous research in both older adults [15, 32] and ovarian cancer survivors [28] has found that older participants report being active in a wide age group environment less appealing than being active alone. However, Beauchamp and colleagues [15] further reported older people prefer to be active with others who are in their age-group. Future research needs to continue to explore how demographic, health, and PA variables are related to PA preferences within a group/social context. Clearly, our results provide some indication that individuals with prediabetes who are already physically active have unique and differing PA preferences when compared to individuals who are not active.

Other PA preferences emerged that deserve to be mentioned. For example, participants who were married or common-law were more likely to want to be active at home versus out of the home. Individuals who were employed were more likely to want to be active during the evening rather than during the day and were more likely to want to be active alone than with others. Those individuals with a BMI $\geq$30 also preferred to be active in the evening. Moreover, individuals who were already physically active were more likely to prefer moderate- or vigorous-intensity PA. This finding may suggest that inactive individuals with prediabetes prefer to start a PA program by engaging in more mild forms of PA (e.g., light walking, or easy cycling). In addition, participants

who are diagnosed with prediabetes for a longer period of time would prefer more scheduled than spontaneous PA opportunities.

These findings strengthen the rationale for PA programs and interventions for individuals with prediabetes to consider individual differences and PA preferences, as opposed to a one-size-fits-all approach to PA prescription and programming. Given the evidence suggesting that individuals engaged in PA programs that were congruent with their PA preferences may demonstrate better attendance, more positive affect and beliefs, and stronger intentions to maintain their activity compared to individuals assigned to PA programs not consistent with their preferences [20, 33-34], researchers and practitioners should elicit information related to PA preferences from the population they are working with. Future PA research (i.e., intervention research) should examine the effect of participant preference for PA on outcomes such as (but not limited to) PA adherence, affect, beliefs, and intentions.

Strengths and Limitations

This is the first study to elicit PA preferences in a large sample of individuals with prediabetes. However, the ability to draw conclusions about the prediabetes population as a whole is limited as the response rate was low, the presence of prediabetes was self-reported, and the sample consisted largely of women. However, demographic profiles between our study and other studies in those at high risk or with diagnosed prediabetes are similar. For example, one study surveying people at high risk of prediabetes also reported a high number of female responders (75% compared to 73% of our sample), a high level of insufficient activity (62% compared to 62% in our sample) and similar comorbidity profiles (84% with at least one comorbidity compared to 82% of our sample) [35]. In addition, the number of participants with a BMI 30 and over (59%) in our

sample is similar to those reported in the DPP (65% in total sample) and the DPS (55%) [36-37]. As with all research based on self-report measures of PA, social desirability and recall bias may have been introduced as those with prediabetes who were interested in and likely to engage in PA may have been more likely to participate or overestimate reports of their PA. In addition, the reliability and validity of the PA preferences scale used has not been tested in a prediabetes population. Nonetheless, the scale has been used when examining PA preferences in various populations [25, 27, 29, 38] and our results have implications for practitioners who intend to develop programs targeting PA among this population.

Conclusions

The main findings from this study indicate the majority of individuals with prediabetes would like to receive PA counseling, were able to participate in a PA program, and are interested in participating in PA programs designed for individuals with prediabetes. We also report various demographic, health, and PA characteristics associated with specific PA preferences in this sample of individuals with prediabetes. Future research should further explore how PA preferences, environmental, health and cognitive determinants shape PA initiation and adherence. Ultimately, practitioners (e.g., PA programmers, trainers, health professionals) need to create a PA context that provides the patient with autonomy in the choices and decisions they make related to their PA pursuits. Further, practitioners need to be cognizant and respectful of individual differences in preferences for PA among people with prediabetes. Designing and implementing PA programs targeted to the preferences of this patient group may enhance the likelihood that the individual will initiate, adhere, and maintain PA.

Practice Implications

A number of specific practice implications are indicated based on the sample used in this study. While it appears reasonable to suggest PA programs for individuals with prediabetes focus on promoting brisk walking, PA programs should be flexible and provide opportunities for other activities (e.g., sports, swimming, resistance training) given the large proportion of individuals preferring these types of activities. Also, it may be beneficial before offering a PA program to identify people who are active versus inactive, as in our sample of people with prediabetes, those who were active did not want PA counseling. This may result in less resources being dedicated to counsel people about PA who are already achieving recommended levels of PA. PA interventions and programs would likely benefit from considering the PA behavior profile of the individual before providing options and advice related to PA programs for individuals with prediabetes. To do this, they may consider having participants respond to a short PA preferences questionnaire similar to the one used in this study by Vallance et al. [25]. The responses could then be used to tailor a program for the individual in order to promote PA and possibly delay or prevent the development of T2D.

Table 5.1. Descriptive statistics for demographic, health and PA variables

Variable[†]	n	%
Gender		
Male	62	26.7
Female	170	73.3
BMI (kg/m^2)		
Non-obese (<29.99)	96	41.4
Obese (≥30)	136	58.6
Age		
<60 years of age	133	57.3
≥60 years of age	99	42.7
Marital status (n=231)		
No partner	63	27.3
Has a partner	168	72.7
Education (n=230)		
No university completed	128	55.7
Completed some university	102	44.3
Income		
<$59,999 / year	104	44.8
≥$60,000 / year	128	55.2
Employment (n=229)		
Not working	101	44.1
Working	128	55.9
Ethnicity (n=230)		
Caucasian	203	88.3
Other	27	11.7
Months since diagnosis*		
<31 months since diagnosis	115	49.6
≥31 months since diagnosis	117	50.4
Comorbidity		
No reported comorbidities	42	18.1
≥1 comorbidity	190	81.9
Physical activity guidelines		
<600 MET.min/wk	144	62.1
≥600 MET.min/wk	88	37.9

[†] Note: Some variables do not equal 232 due to missing data.

* 31 months was the median of the sample.

Table 5.2. Descriptive statistics for PA preferences of individuals with prediabetes

Preference name[†]	Preference question	n	%
Counseling	Would you like to be counseled about physical activity at some point (n=231)		
	Yes	81	35.1
	No	59	25.5
	Maybe	91	39.4
Ability	Are you be able to participate in a physical activity program designed for persons with prediabetes (n=229)		
	Yes	175	76.4
	No	10	4.4
	Maybe	44	19.2
Interest	Would you be interested in a physical activity program designed for persons with prediabetes (n=229)		
	Yes	130	56.8
	No	33	14.4
	Maybe	66	28.8
Company	Who would you prefer to be physically active with (n=231)		
	Alone	57	24.7
	With other people with prediabetes	45	19.5
	With friends	35	15.2
	With family	18	7.8
	No preference	76	32.9
Location	Where would you prefer to be physically active (n=227)		
	At home	75	33.2
	At a community fitness centre	64	28.3
	At a hospital program	12	5.3
	No preference	75	33.2
Time of day	What time of day would you prefer to be physically active (n=226)		
	Morning	90	39.3
	Afternoon	34	14.8
	Evening	55	24.0
	No preference	50	21.8
Intensity	What intensity would you prefer your physical activity program to be (n=230)		
	Low intensity	27	11.7
	Moderate intensity	156	67.8
	High intensity	28	12.2
	No preference	19	8.3

Variability	What types of physical activities would you like to perform (n = 221)		
	Same activity each session	59	26.7
	Different activities each session	162	73.3
Supervision	How would you prefer to perform these physical activities (n=218)		
	Supervised/instructed	132	60.6
	Unsupervised/self-paced	86	39.4
Structure	How would you prefer the structure of your physical activity program (n=215)		
	Spontaneous/flexible	62	28.8
	Scheduled (i.e. specific days/times)	153	71.2

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† Note: Some variables do not equal 232 due to missing data.

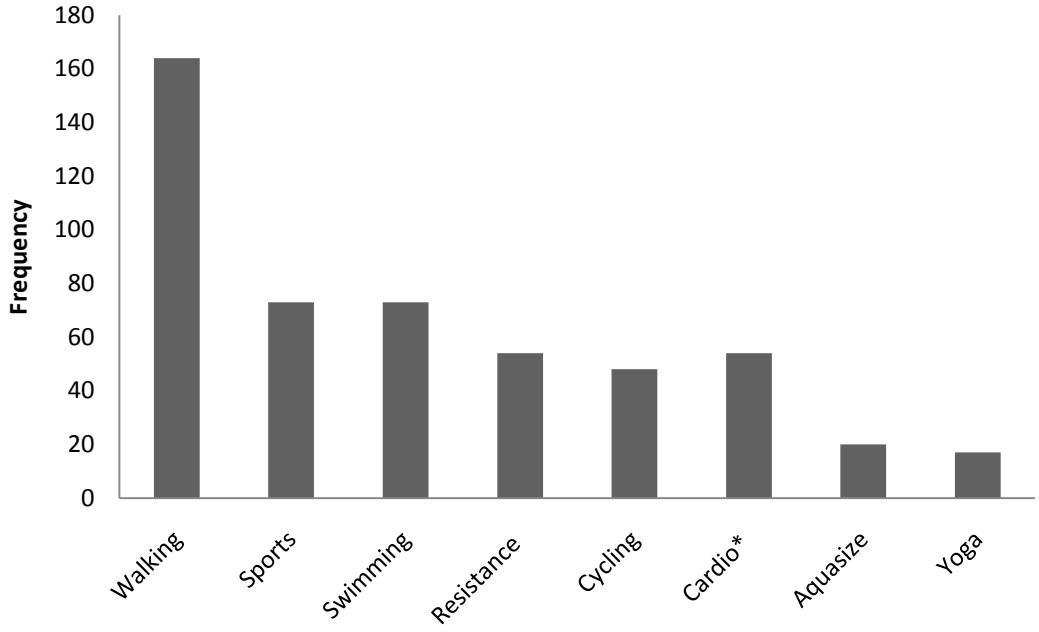
Table 5.3. Associations between demographic, health and PA variables and PA preferences

Preference name	Model	OR (95% CI)
Counseling	Comorbidity	0.37 (0.14-0.99)*
0 = No	Gender	0.56 (0.29-1.08)
1 = Yes	Activity status	0.51 (0.28-0.95)*
Interest	Time since diagnosis	2.13 (0.97-4.69)
0 = No	Activity status	0.42 (0.20-0.89)*
1 = Yes		
Company	Employment	2.12 (1.05-4.29)*
0 = With others	Income	1.83 (0.88-3.84)
1 = Alone	Activity status	2.12 (1.05-4.29)*
Location	Marital status	2.47 (1.19-5.13)*
0 = Out		
1 = At home		
Time of day	BMI (kg/m^2)	3.40 (1.58-7.33)*
0 = Day	Age (years)	0.53 (0.22-1.31)
1 = Night	Employment	4.63 (1.83-11.72)*
Intensity	Education	2.25 (0.83-6.10)
0 = Low intensity	Income	2.32 (0.92-5.85)
1 = Moderate/ vigorous intensity	Activity status	4.06 (1.15-14.30)*
Structure	Time since diagnosis	2.30 (1.25-4.21)*
0 = Spontaneous		
1 = Scheduled		

*P ≤ 0.05

**Comorbidity 0= none and 1 = at least one, employment 0=not employed and 1=employed, gender 0= female and 1=male, activity status 0=inactive and 1=active, education 0=no university and 1=university completed, time since diagnosis 0=<31 months and 1=≥31 months, BMI 0=<30 and 1=≥30, income 0=<60,000 and 1=≥60,000, marital status 0=no partner and 1=partner, and age 0=<60 years and 1=≥60 years.

Figure 5.1. Preferred physical activities of individuals with prediabetes



*Cardio activities include aerobics, jogging, walking/running on a treadmill and exercising on an elliptical trainer.

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CHAPTER 6:

Study 4: Understanding physical activity and fat and fibre intake in individuals with prediabetes: An application of Social Cognitive Theory

Understanding physical activity and fat and fibre intake in individuals with prediabetes: An application of Social Cognitive Theory

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INTRODUCTION

Prediabetes describes individuals who have impaired fasting glucose (IFG) and/or impaired glucose tolerance (IGT) [1]. Among adults aged 45 years and older, the prevalence of prediabetes is approximately 25% [2-4]. Several research studies have demonstrated that positive lifestyle changes result in a substantial reduction in type 2 diabetes (T2D) risk. In particular, lifestyle modification interventions should include: a reduction in weight of at least 5-10%; an increase in moderate-intensity physical activity (PA) to at least 150 minutes per week (30 minutes, 5 days a week); and a reduction in fat and saturated fat calories accompanied by an increase in fibre similar to Dietary Reference Intakes (DRI) for the general population [2-5]. Without lifestyle changes and/or pharmacologic intervention, people with prediabetes will likely develop T2D [6-8]. The Canadian Diabetes Association (CDA) recently added a clinical practice guideline on the prevention of diabetes that promotes lifestyle modifications that result in a 5% weight loss and regular PA and/or pharmacologic therapy [9].

We previously reported that only 38% of individuals with prediabetes were meeting current public health PA guidelines and those meeting guidelines reported higher physical and mental health-related quality of life (HRQoL) than those not meeting guidelines [10]. These findings, and those of previous research, provide some preliminary data on the determinants of health behavior (i.e., PA, nutritional intake, weight control behaviors) among individuals with prediabetes. Research in this area may assist clinicians and practitioners in developing resources and programs aimed at facilitating lifestyle modifications that result in a 5% weight loss.

Much of the research in diabetes prevention appears to have targeted individuals without considering the role of theory including contextual, social,

community, cultural or environmental influences on behavior [11]. Behavioral theories are composed of measurable constructs (e.g., self-efficacy, social support) that provide researchers and practitioners a systematic framework in which to explain and predict health behaviors [12-13]. Furthermore, researchers have contended that theoretically-based programs may enhance the likelihood that individuals will successfully change their behavior [12]. Therefore, incorporating an approach based on behavioral theory into a diabetes prevention program may increase the proportion of participants who successfully change their behavior [14-15]. It is through the implementation of behavioral theories, and thorough analyses of the potential moderators and /or mediators of behavior change (i.e., theoretical constructs) that researchers and practitioners can begin to understand how to develop and implement theoretically based programs that maximize opportunities for behavior change [15].

Social Cognitive Theory (SCT) has proven useful for understanding and explaining health behaviors of individuals [16]. SCT is based on the concept of reciprocal determinism or the interaction between behavior, the person, and the environment [17]. *Self-efficacy* is considered the key organizing construct within SCT and is defined as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given levels of attainment” (p. 300) [18]. According to Bandura [19], self-efficacy influences the activities that individuals choose to approach, the effort expended on such activities, and the degree of persistence in the face of failure or obstacles. It is also theorized to influence whether or not an individual forms a goal (i.e., *goal formation*) to perform a specific behavior [16]. The formation of a goal should then directly influence behavior. Another important construct in SCT is *outcome expectations*, which refers to the expected outcomes associated with the performance of a behavior

[16]. These expectations serve as incentives or disincentives to forming a goal and performing a specific behavior depending on whether the anticipated outcomes are positive or negative [16]. *Sociostructural factors* (i.e., both impediments and facilitators) also impact goal formation and include both positive and negative environmental influences on motivation to perform a behavior [16].

Constructs from SCT, particularly self-efficacy, have been identified as important determinants of weight change, dietary intake and PA behavior in adults [20-22]. In adults with T2D, Plotnikoff et al. [23] identified self-efficacy was significantly related to positive outcome expectations, goals, and leisure-time PA. Overall, SCT constructs explained 59% of the variance in goal formation and 9% of the variance in PA [23]. In other studies in those with T2D, significant relationships have been observed between self-efficacy and self-care behaviors such as diet and physical activity [24-25]. It appears SCT is relevant to a prediabtes population as previous associations between SCT constructs and key behaviors have been demonstrated. For example, in adults with prediabetes participating in the diabetes prevention program, higher baseline PA self-efficacy was significantly correlated with higher levels of PA [26]. Recent research supports dividing PA-related self-efficacy into three domains: a) task efficacy (i.e., *follow directions to complete physical activity*), b) coping efficacy (i.e., *be physically active when you lack energy*), and c) scheduling efficacy (i.e., *arrange your schedule to include regular physical activity*) [27]. Although research is limited in identifying what behavioral theory or constructs would be best to target in a prediabetes population, it appears that examining constructs from SCT is a logical first step.

While SCT constructs appear to be important predictors of dietary intake and PA in other populations, no studies have explored the role of SCT constructs

in understanding fat and fibre intake as well as PA in a prediabetes population. Therefore, the objectives of this study were to investigate the role of SCT in understanding fat and fibre intake and PA in a sample of individuals with diagnosed prediabetes. We hypothesized that self-efficacy (i.e.,low-fat diet, high fibre diet, task PA, coping PA and scheduling PA) would be significantly related to outcome expectations, goal formation and fat and fibre intake and leisure-time PA in individuals with prediabetes. We further hypothesized that goal formation and outcome expectations would be signficiantly related to fat and fibre intake and PA and that outcome expectations would be related to goal formation.

METHODS

Participants

Participants were 232 individuals with prediabetes living in Alberta, Canada who had registered in a prediabetes education class. To be included in this study, participants had to have a doctor or nurse tell them they had prediabetes, IFG or IGT, be at least 18 years of age, have a fixed address, and be able to read English.

Design and Procedures

The design and procedures of this study are presented in detail elsewhere [10]. Here we provide a brief summary. Ethical clearance to conduct this study was granted by the University of Alberta's Health Research Ethics Board. This study was a cross-sectional survey design. Survey packages were sent to people who had registered in a prediabetes education class. Survey packages were mailed in July, 2008, with a second survey package sent to non-responders 3 weeks later. Informed consent was implied by return of the survey and the final response rate was 17%. In a generalizability analysis, we found few meaningful demographic differences existed between those who participated and

did not participate in the survey. There was no difference between those who did and did not participate in age ($p > .05$). However, fewer men responded ($p < .01$) to the survey (27%) compared to those who did not respond (35%).

Measures

Demographic information was gathered via self-report and included age, gender, marital status, cultural background, education, income, and employment status.

Health information was also gathered via self-report and included height, weight, smoking, the number of months since diagnosis, and comorbidities (i.e., high blood cholesterol, high blood pressure, stroke, angina and heart attack). Body mass index (BMI) was calculated from self-report height and weight according to national guidelines [28]. Specifically, a BMI of 30 or higher was classified as obese, a BMI less than 30 but greater than 25 was classified as overweight and a BMI less than or equal to 25 was classified as normal weight.

Physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [29]. The GLTEQ was modified to include the average duration of each PA session reported for each different level of intensity (i.e., mild, moderate, vigorous) [30]. Weekly minutes were calculated by multiplying the frequency of both moderate and vigorous PA by the duration in minutes, respectively. Participants' weekly minutes in moderate- and vigorous-intensity PA were multiplied by 4.0 METS for moderate activity and 7.5 METS for vigorous activity to create MET.minutes (MET.min) [31]. Weekly MET.min of moderate and vigorous activity were summed to create total weekly MET.min (MET.min/wk). An independent evaluation of the GLTEQ found its reliability to compare favorably to nine other self-report measures of PA based on test-retest scores, objective activity monitors and fitness indices [32].

Dietary Intake was assessed using the National Cancer Institute's Multifactor Screener [33]. The Multifactor Screener (MS) assesses approximate intakes of fruits and vegetables pyramid servings (excluding french fries), percent energy from fat, and fibre grams (g). The MS asks respondents to report how frequently they consume foods in 16 categories. Respondents are asked to *'think about what you usually ate and drank during the past month*. Individuals indicate their responses on a nine-point Likert scale ranging from 1 (never) to 9 (4 times per day). All reported items are standardized to the common *daily* frequency. The MS was developed using US national food consumption data (United States Department of Agriculture's 1994-96 Continuing Survey of Food Intakes of Individuals) and has demonstrated suitable indices of validity and reliability [33]. For example, correlations between estimated true intake and MS estimates ranged from 0.54 to 0.76 and the MS reflected approximately 25 to 50% of the variance in estimated true intake.

Self-efficacy for PA was assessed using the Multidimensional Self-Efficacy for Exercise Scale (MSES) [27]. The MSES contains nine items designed to assess three different domains of self-efficacy for PA participation including task efficacy (i.e., *follow directions to complete PA*), coping efficacy (i.e., *be physically active when you lack energy*), and scheduling efficacy (i.e., *arrange your schedule to include regular PA*). All items are rated on a 10-point Likert scale ranging from 0 (no confidence) to 10 (complete confidence). All items begin with the stem "Over the next month, how confident are you that you can do the following tasks?" PA was defined as completing at least 30 minutes of moderate-intensity physical activity on at least 5 days of the week (e.g., light sweating, some increase in heart rate, and you need to catch your breath when talking). Recent empirical data provides encouraging evidence of reliability and

suitable psychometric indices for the MSES [27]. Cronbach's alpha coefficients in this study for task, coping and scheduling efficacy were 0.95, 0.90, and 0.95 respectively.

Low-fat diet and high-fibre diet self-efficacy were assessed using four self-efficacy items developed by Armitage and Conner [34]. Individuals are asked to rate if "they have the ability, if they are likely, if they are able, and if they are confident, they can eat a low-fat diet over the next month or alternatively a high-fibre diet over the next month". Items are rated on a seven-point Likert scale ranging from 1 (definitely do not, very unlikely to eat a low-fat diet, very unsure, and strongly disagree, respectively) to 7 (definitely do, very likely to eat a low-fat diet, very sure, and strongly agree, respectively). A low-fat diet was described for participants as a) choosing vegetables, fruit, and grain products that are lower in fat, b) choosing lower fat milk products, c) choosing lean meats and preparing them with little added fat, and d) limiting foods and drinks high in fat. A high-fibre diet was described for participants as a) choosing whole grains for at least half of the grain products you eat, b) eating beans and lentils, c) eating cereal or bread that is a 'high source of fibre', and d) eating at least 7 servings of fruit and vegetables every day. According to Armitage and Conner [34], the self-efficacy scale has good internal consistency with a Cronbach alpha coefficient of 0.83. The Cronbach alpha coefficients were 0.95 for the fat items and 0.96 for the fibre items in the current study.

Outcome expectations for PA, fat and fibre was assessed using the Multidimensional Diabetes Questionnaire outcome expectancies items (MDQ) [35]. Individuals were asked two dietary questions: 1) "How important do you think it is to eat a low-fat diet?", and 2) "How important do you think it is to eat a high-fibre diet to help control your prediabetes?". The PA question was, "To what

extent do you think being physically active most days of the week for at least 30 minutes a day is important for controlling your prediabetes". Low-fat and high-fibre diet and PA were defined as described above. Response options are rated on a seven-point Likert scale ranging from 1 (not at all important) to 7 (very important).

Goal formation for PA, fat and fibre was assessed by asking for a response to the questions, "I expect to eat a low-fat diet or alternatively I expect to eat a high-fibre diet, or I expect to be physically active most days of the week, over the next month" adapted from Luszczynska and Schwarzer [36]. Low-fat and high-fibre diet and PA were defined as described above. Response options are rated on a seven-point Likert scale ranging from 1 (definitely do not) to 7 (definitely do).

Sociostructural factors for fat and fibre were assessed using one food security item taken from the Food Behavior Checklist (FBC) [37]. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [38]." Briefel et al. [39] have advised when assessing dietary intake using short assessment tools adding an item measuring food security is imperative. The FBC item asked "do you ever run out of food before the end of the month." Response options include "never", "sometimes", "often", and "always". The FBC has been tested in a low-income, low-literacy population and is designed for use in community health promotion interventions [37].

Sociostructural factors for PA were assessed using 20 items measuring walking distance in minutes from a participant's home to different businesses and facilities (e.g., supermarket, library, bus stop, park and fitness facility). These

items were adapted from the Neighbourhood Environment Walkability Scale (NEWS) [40] and scored using the recommended scoring procedures [41]. Response options included “1-5 minutes” = 5, “6-10 minutes” = 4, “11-20 minutes” = 3, “21-30 minutes” = 2 and “31+minutes” and “I don’t know” = 1 [40]. A higher score represents closer access to a person’s home; particularly if walking.

Statistical Analyses

Descriptive statistics were calculated for all variables. Pearson product moment correlations were used to determine the bivariate associations between variables. Three multiple regression analyses were conducted to determine the multivariate associations between SCT constructs and PA, percent energy from fat, and fibre gram intake, respectively. For the primary analyses, path analysis was used to determine the strength of relationship in a recursive model between SCT variables and dietary intake (i.e., % energy from fat, fibre grams) and PA (PA MET.min/wk). Path analysis is an extension of multiple regression that allows the researcher to study the direct and indirect relationships between constructs and behavior [42]. Path diagrams include both exogenous and endogenous variables. According to Pedhazur [42], exogenous variables are those influenced by variables outside of the model (e.g., self-efficacy, food security, access to PA facilities). Endogenous variables are those whose variance is explained by other variables in the model and exogenous variables [42]. As with regression analysis, in path analysis the significance of the relationships between exogenous and endogenous variables are determined, and standardized beta (β) coefficients are used to quantify the relationships. The path analysis conducted in this study followed the guidelines of Pedhazur [42], wherein each endogenous variable in the model is regressed on the exogenous and other endogenous/predictor variables in the causal pathway.

Three path analysis models were constructed for each criterion variable. For PA, the predictor variables were access (sociostructural factor), task efficacy, coping efficacy, scheduling efficacy, PA outcome expectations, and PA goal formation. For % energy from fat, predictor variables consisted of goal formation (for fat intake), outcome expectations (for fat intake), and self-efficacy (low-fat diet). For fibre grams per day, the predictors were food security (sociostructural factor), goal formation (for fibre intake), outcome expectations (for fibre intake), and self-efficacy (for high-fibre diet). Path analyses were adjusted for age, BMI or education if these variables demonstrated a significant correlation with PA or fat and fibre outcome expectations, goal formation or behavior. Age, BMI and education were chosen as covariates as they have demonstrated significant relationships with the outcome variables in previous studies in people with prediabetes and T2D [10, 30].

RESULTS

Demographic, health, and food security characteristics are presented in Table 6.1. Briefly, the mean (SD) age of our sample was 58 (11.0) years, 73% were female, 72% were married or common-law, 88% reported descending from a Caucasian cultural background, 35% completed university/college, 40% had a family income >$80000, and 53% were currently working full or part-time. Approximately 59% were classified as obese (i.e., BMI ≥ 30), 89% reported no smoking, and about 59% reported having high blood cholesterol and/or high blood pressure. The median number of months since diagnosis was 31 months or 2.6 years. Almost 17% of participants reported lacking food security at least “sometimes” in a month.

Fat, Fibre, and Fruit and Vegetable Intakes

Fat mean intake expressed as percent energy from fat was 31.3% (SD = 5.7). Men and women had significantly different mean fibre intakes (t = -2.5, df = 230, p < 0.05) therefore their mean and median intakes are reported separately. For men, their mean/median fibre intake was 24.0 / 22.3 g/d (SD = 10.1 / IQR = 16.8 - 27.6). For women their mean/median fibre intake was 19.6 / 17.3 g/d (12.6 / 13.2 - 22.3). Fruit and vegetable mean intake (excluding french fries) was 5.6 (1.9) servings a day.

Association Between Fat Intake and Social Cognitive Variables

The bivariate correlations between demographic variables, fat intake and SCT variables are presented in Table 6.2. Daily % energy from fat was negatively correlated with age (r = -.14, p < .05), self-efficacy (for low-fat) (r = -.18, p < .01) and goal formation (for low-fat) (r = -.16, p < .05) and positively correlated with BMI (r = .23, p < .01). Due to a high correlation between self-efficacy and goal formation (r = .92, p < .01), collinearity was present when these variables were entered into the regression simultaneously (low-fat self-efficacy Tolerance = .16 and VIF = 6.3; low-fat goal Tolerance = .16 and VIF = 6.2) for the path analysis (see Figure 6.1). Therefore the relationship between goal formation and behavior, and self-efficacy and behavior, were analyzed in separate regression models, thus eliminating the problem of collinearity. Self-efficacy (for low-fat) had significant effects on outcome expectations (for low-fat) (β = .40, p < .01), goal formation (for low-fat) (β = .90, p < .01) and percentage of energy from fat (β = -.14, p < .05). No other significant relationships were identified. Self-efficacy (for low-fat), outcome expectations and goal formation explained approximately 9% of the variance in fat intake as described in Table 6.5. Self-efficacy (for low-fat) and

outcome expectations explained approximately 84% of the variance in goal formation and self-efficacy (for low-fat) explained approximately 16% of the variance in outcome expectations.

Association Between Fibre Intake and Social Cognitive Constructs

Table 6.3 displays bivariate correlations between demographic variables, fibre intake and the SCT variables. Daily fibre intake was positively correlated with servings of fruit and vegetables (r = .69, p < .01), self-efficacy (for high-fibre) (r = .26, p < .01), and goal formation (for high-fibre) (r = .24, p < .01). Similar to the low-fat model, in the path analysis (see Figure 6.2), collinearity was present between self-efficacy and goal formation (r = .89, high-fibre self-efficacy Tolerance = .20 and VIF = 5.0; high-fibre goal formation Tolerance = .21 and VIF = 4.9). Therefore the relationship between goal formation and behavior, and self-efficacy and behavior, were analyzed in separate regression models, thus eliminating the problem of collinearity. Self-efficacy (for high-fibre) had direct effects on outcome expectations (for high-fibre) (β = .47, p < .01), goal formation (for high-fibre) (β = .87, p < .01) and daily fibre gram intake (β = .28, p < .01). Goal formation (for high-fibre) was positively associated with daily fibre gram intake (β = .26, p < .01). As participants ran out of food more often, self-efficacy for eating a high-fibre diet decreased (r = -.17, p < .01). No significant effects were identified between outcome expectations and goal formation or fibre intake. Self-efficacy (for high-fibre), outcome expectations and goal formation explained approximately 8% of the variance in fibre intake as described in Table 6.5. Self-efficacy (for high-fibre) and outcome expectations explained approximately 80% of the variance in goal formation and self-efficacy (for high-fibre) explained approximately 22% of the variance in outcome expectations.

Physical Activity

Details pertaining to PA MET.min/wk in this sample have been published elsewhere [10]. In summary, 38% (*n=88*) of the sample were achieving PA guidelines (i.e., achieving ≥ 600 MET.min/wk). Participants were engaging in a mean/median of 232.1 / 0.0 (SD = 550.1 / IQR = 0.0 - 0.0) vigorous MET.min/wk, 373.9 / 80.0 (615.1 / 0.0 - 530.0) moderate MET.min/wk, and 606.0 / 240.0 (852.8 / 0 - 975.0) total (vigorous plus moderate) MET.min/wk. The mean walking distance from home to facilities and businesses was approximately 11-30 minutes.

Association Between PA MET.min/wk and Social Cognitive Constructs

Table 6.4 displays the bivariate correlations between demographic, SCT variables and PA MET.min/wk. Total PA MET.min/wk was positively correlated with access to diverse facilities (r = .13, p < .05), task efficacy (for PA) (r = .42, p < .01), scheduling efficacy (for PA) (r = .48, p < .01), coping efficacy (for PA) (r = .38, p < .01), PA goal formation (for PA) (r = .45, p < .01), and outcome expectations (for PA) (r = .17, p < .01). BMI was negatively correlated with PA MET.min/wk (r = -.19, p < .01). In the path analysis (see Figure 6.3), when scheduling, coping and task efficacy were regressed together significant collinearity was present (scheduling efficacy Tolerance = .17 and VIF = 6.0; coping efficacy Tolerance = .34 and VIF = 2.9; task efficacy Tolerance = .28 and VIF = 3.6). Therefore the relationships between scheduling, coping and task efficacy and the other SCT constructs were analyzed in separate regression models, thus eliminating the problem of collinearity.

We found that scheduling efficacy had direct effects on outcome expectations (for PA) (β = .33, p < .01), goal formation (for PA) (β = .74, p < .01) and PA MET.min/wk (β = .30, p < .01). In the scheduling efficacy SCT model,

goal formation (for PA) had a direct effect on PA MET.min/wk (β = .20, p < .05) and outcome expectations (for PA) had a direct effect on goal formation (for PA) (β = .10, p < .05). No other significant relationships were identified in this model. Scheduling self-efficacy, outcome expectations and goal formation explained approximately 27% of the variance in PA as described in Table 6.5. Scheduling self-efficacy and outcome expectations explained approximately 63% of the variance in goal formation and scheduling self-efficacy explained approximately 10% of the variance in outcome expectations.

Coping efficacy had direct effects on outcome expectations (for PA) (β = .24, p < .01), goal formation (for PA) (β = .55, p < .01) but not PA MET.min/wk (β = .14, p > .05). For the coping efficacy SCT model, goal formation (for PA) had a direct effect on PA MET.min/wk (β = .34, p < .01) and outcome expectations (for PA) had a direct effect on goal formation (for PA) (β = .21, p < .01). No other significant relationships were identified in this model. Coping self-efficacy, outcome expectations and goal formation explained approximately 24% of the variance in PA as described in Table 6.5. Coping self-efficacy and outcome expectations explained approximately 44% of the variance in goal formation and coping self-efficacy explained approximately 5% of the variance in outcome expectations.

Task efficacy had direct effects on outcome expectations (for PA) (β = .28, p < .01), goal formation (for PA) (β = .54, p < .01) and PA MET.min/wk (β = .22, p < .01). In the task efficacy SCT model, goal formation (for PA) had a direct effect on PA MET.min/wk (β = .30, p < .01). Outcome expectations (for PA) had a significant effect on both goal formation (for PA) (β = .19, p < .01) and PA (β = .21, p < .01). No other significant relationships were identified in this model. Task

self-efficacy, outcome expectations and goal formation explained approximately 26% of the variance in PA as described in Table 6.5. Task self-efficacy and outcome expectations explained approximately 41% of the variance in goal formation and task self-efficacy explained approximately 8% of the variance in outcome expectations.

DISCUSSION

The objectives of this study were to investigate the role of social cognitive theory in understanding fat and fibre intake and PA MET.min/wk in a sample of individuals with diagnosed prediabetes. We partially confirmed our hypotheses as significant correlations emerged for self-efficacy and outcome expectations, goal formation and all three health behaviors (PA, low-fat, high-fibre). Further, significant correlations existed between goal formation and all three behaviors. Outcome expectations were only significantly correlated with PA MET.min/wk in the task self-efficacy regression model and were not significantly correlated with fat and fibre intake. In addition, outcome expectations were significantly correlated with goal formation for all three types of PA self-efficacy. Overall, the SCT framework was able to explain some of the variance in fat and fibre intake and PA (9%, 8% and 24-27% respectively). Our data suggests that SCT-based strategies (either interventions or programs) to facilitate PA, fibre intake, and reduce fat intake should focus on building self-efficacy for each respective health behavior as well as encouraging goal formation. Intervention research in other populations suggests a critical role for SCT and self-efficacy in the PA and nutrition domain [43-46]. Indeed, some researchers have contended that the effects of self-efficacy on health behaviors are stronger than psychosocial determinants found in other theoretical models [16, 47].

Fat and fibre self-efficacy was significantly related to outcome expectations, goal formation and fat and fibre intake. To our knowledge, this is the first specific application of the SCT framework to fat and fibre intake in a sample of individuals with prediabetes. However, we can compare our results to data from SCT research in other populations. For example, a recent study by Anderson and colleagues [45] found the SCT framework explained 35% of the variance in fat intake and 53% of the variance in fibre intake. While the measurement model was different than the model applied in our study, some of the path coefficients (i.e., effects) were consistent across the studies. For example, our study as well as the study by Anderson [45] reported that individuals with higher self-efficacy had lower levels of fat intake (β = -.14 and -.25, respectively); however in a recent study by King and colleagues [25] no relationship was evident between self-efficacy for healthy eating and low-fat intake (β = -.08, p = 0.16). In both our study and the study by Anderson [45] those with higher self-efficacy for eating a high-fibre diet had higher levels of fibre intake (β = .28 and .30, respectively). The role of outcomes expectations in predicting fat and fibre intake was also similar as outcome expectations did not appear to have any effect on fat or fibre intake in our study or the study by Anderson [45]. In a sample of older women [48], as seen in some of our study results, low-fat self-efficacy demonstrated direct effects on outcome expectations but outcome expectations were not a significant predictor of either PA or dietary behavior in a sample of older women. The findings from this and other studies provide further evidence that self-efficacy is likely an important determinant of goal formation and fat and fibre intake.

Of interest, our study found a significant relationship between food security and self-efficacy for a high-fibre diet suggesting that as food security decreases, self-efficacy for eating a high-fibre diet also decreases. One possible explanation is that high-fibre foods such as fruit and vegetables and high-fibre breads and cereals are viewed as higher cost items so individuals who run out of food on a monthly basis do not believe they are able to eat a high-fibre diet; however, in our study food security was not significantly correlated with fruit and vegetable intake. It may be that other sociostructural factors, such as social-environmental support may also be relevant to understanding fat and fibre intake in individuals with prediabetes.

A review of SCT variables and PA in individuals with T2D [49] found statistically significant relationships between self-efficacy and PA. This review found mixed results for associations between outcome expectancies and PA [49] which is consistent with our findings of only outcome expectations in the task efficacy model demonstrating a significant relationship with PA. Other reviews have also identified mixed results for the effect of outcome expectations on PA [50]. The findings in our study suggest scheduling, task and coping efficacy all had significant effects on outcome expectations, goal formation and PA MET.min/wk (excluding coping efficacy on PA) and this supports recent theoretical conceptualizations supporting a multidimensional conceptualization of PA self-efficacy [27]. The lack of direct effect of coping efficacy on PA in our study is divergent from a large body of literature which suggests coping efficacy is an important predictor of PA [51-53]. However, coping efficacy indirectly impacted PA through its effect on goal formation. Our data suggest scheduling and task efficacy may be important determinants of PA in our study participants. Scheduling and task efficacy may influence PA either directly, or via facilitating

the formation of goals and outcome expectations (excluding scheduling efficacy), which may then influence PA. Given these findings, SCT-based PA interventions in this population focused on issues related to scheduling efficacy (e.g., time management), coping efficacy (e.g., problem solving around barriers such as lacking energy), task efficacy (e.g. providing understandable instructions) and goal formation (i.e., goal-setting, implementation intentions) may be warranted.

The mean intake of fat observed in this study was 31.3% (SD = 5.7) which is within the Acceptable Macronutrient Distribution Range for healthy adults of 20-35% [5], but is slightly higher than the proportion of fat recommended by the diabetes prevention studies of 25-30% of calories [54-55]. For men and women, their median fibre intake was 22.3 and 17.3 g/d respectively (IQR = 16.8 - 27.6, 13.2-22.3 respectively). Both of these fibre intakes are lower than current recommendations for Adequate Intake of 30-38 g/d for men and 21-25 g per day for women (i.e. based on 14 g per 1000 kilocalories consumed) [5]. The fibre intakes observed in this study were also lower than what was recommended in the Finnish diabetes prevention trial of 15 g of fibre/1000 kcal or more [55]. For fruit and vegetable intake, the USDA recommends for a 2,000 calorie diet that individuals consume approximately four servings of fruit a day and four to five servings of vegetables a day for a total intake of eight to nine servings per day [56]. This is a difference of approximately 2.4 to 3.4 servings less per day between U.S. guidelines and what was observed in our study. Based on these results, even though participants in this study had attended an education class advising them to reduce fat intake, increase fibre intake and eat more fruits and vegetables, many were not successfully meeting current guidelines. Additional research needs to explore if designing educational interventions using theoretical

frameworks like SCT will positively impact dietary consumption in those with prediabetes.

Our study has several important strengths and limitations that should be taken into account when interpreting our data and planning future research. First, our findings add important and relevant information to the relatively small body of literature examining PA and diet-related determinants in individuals with prediabetes. Specifically, to our knowledge this is the first study to explain PA and dietary intake within the SCT framework in a sample of individuals with prediabetes. Further strengths of our study include the use of appropriate behavior-specific SCT measures (e.g., self-efficacy, outcome expectations) [27, 35-36], and PA and dietary intake measures (i.e., Multifactor Screener) [29, 33] that have demonstrated evidence of validity and reliability. The main limitations are the cross-sectional design of the study, the small sample size, the low response rate, the presence of prediabetes was self-reported, and the sample consisted largely of women. Given the cross-sectional design of our study, we are assuming past PA is a suitable proxy measure for future PA. Research however, has demonstrated that past PA can act as a reasonable proxy measure of future PA when measured in a cross-sectional design [57]. Our low response rate and high percentage of female responders limits the ability to draw conclusions about the population with prediabetes. However, despite our low response rate, demographic profiles between our study and other studies in those at high risk or with diagnosed prediabetes are similar. For example, in one study [58] a higher number of females also responded to a survey (75% compared to 73% of our sample), had a lower number of people respond who were normal weight (8% compared to 15% of our sample) and reported similar comorbidity profiles of their sample (55% with hypertension compared to 59% of

our sample, 43% with treated hyperlipidemia compared to 58% of our sample, and 6% reported a heart attack compared to 6% in our sample). In addition, the average BMI (31.2, SD = 6.4) in our sample is similar to those reported in both the DPS (31.3, SD = 4.5) and the DPP (34, SD = 6.7), while other demographics are different [59-60]. It is also possible selection and recall bias may have occurred. For example, more active individuals with prediabetes may have chosen to respond to the survey (although only 38% of our sample was considered active) and participants may have provided more favorable responses due to social desirability (although participants reported consuming much less fibre than current public health recommendations). Finally, a more conservative alpha could have been employed to control for the possibility of increased Type I error associated with multiple analyses; however the majority of the significant relationships noted were below $p = 0.01$.

Our data provide a strong impetus for future research exploring PA and dietary intake in individuals with prediabetes using the SCT model. Researchers and practitioners should explore and consider components from other social cognitive models (e.g., Theory of Planned Behavior, Protection Motivation Theory) to further understand PA and dietary intake in adults with prediabetes. Clearly, further evaluative inquiry is needed to establish support for the use of the SCT as a framework for developing, implementing, and evaluating PA and dietary behavior change interventions in this population. Research efforts into factors that help individuals with prediabetes adopt and maintain regular PA as well as reduce fat intake while increasing fibre intake (and ultimately, lose weight) may prevent the development and onset of T2D.

Table 6.1. Demographic and health characteristics [10]†

Characteristic	No. of Respondents	%	Mean (SD)
Age (years)	232		58.1 (11.0)
Female gender	232	73.3	
Marital Status	231		
Married/Common Law	168	72.7	
Not married	63	27.3	
Cultural Background	230		
Caucasian	203	88.3	
Other	27	11.7	
Education	230		
Some High School	27	11.7	
Completed High School	57	24.8	
Some University/College	44	19.1	
Completed University/College	80	34.8	
Some Graduate School	12	5.2	
Completed Graduate School	10	4.3	
Annual Family Income	201		
< $59,999	104	44.8	
> $60,000	128	55.2	
Employment Status	229		
Employed Full/Part-Time	128	55.9	
Not working	101	44.1	
Body Mass Index (kg/m^2)	232		31.2 (6.4)
Normal Weight (BMI<25)	34	14.7	
Overweight (BMI$\geq$25 – 29.9)	62	26.7	
Obese (BMI$\geq$30)	136	58.6	

Smoking	232		
Not at all	206	88.8	
Occasionally or daily	26	11.2	
Months Since Diagnosis	232	Median (IQR)	31.0 (22.3 – 42.5)
Comorbidities	232		
High Blood Cholesterol	134	57.8	
High Blood Pressure	137	59.1	
Stroke	10	4.3	
Angina	22	9.5	
Heart Attack	13	5.6	
Food security: run out of food / month			
Never	192	82.8	
Sometimes	31	13.4	
Often	5	2.2	
Always	4	1.7	

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† Numbers may not equal 232 due to missing data, study conducted in Edmonton, Alberta in August-September, 2008.

Data are presented as the mean/median (standard deviation/Interquartile range) for continuous variables and frequency (percentage) for categorical variables.

Table 6.2. Bivariate Pearson product-moment correlations among fat intake, social cognitive constructs, and demographic variables

Variable	M	SD	2.	3.	4.	5.	6.	7.	8.	9.
1. Age (years)	58.1	11.0	-.20**	-.09	-.19**	.03	.05	.07	-.05	-.14*
2. BMI (kg/m^2)	31.2	6.4		-.11	.12	-.07	-.16*	-.19**	.00	.23**
3. Education†					-.07	.06	.15*	.12	-.02	-.12
4. Food security (run out of food)	1.2	0.6				.00	-.10	-.14*	.10	.10
5. Servings of fruit and vegetables	5.6	1.9					.25**	.24**	.03	-.12
6. Low-fat self-efficacy	22.2	5.5						.92**	.39**	-.18**
7. Low-fat goal formation	5.4	1.6							.37**	-.16*
8. Low-fat outcome expectations	6.5	1.1								-.09
9. Percentage energy from fat	31.3	5.7								

Study conducted in Edmonton, Alberta in August-September, 2008. † Education scale:(completed some high school to completed graduate school)
Note. *p < .05, **p < .01.

Table 6.3. Bivariate Pearson product-moment correlations among fibre intake, social cognitive constructs, and demographic variables

Variable	M	SD	2.	3.	4.	5.	6.	7.	8.	9.
1. Age (years)			-.20**	-.09**	-.19**	.03	.13	.18**	.07	-.05
2. BMI (kg/m^2)				-.11	.12	-.07	-.15*	-.18**	-.08	.05
3. Education†					-.07	.06	.18**	.16*	.01	.02
4. Food security (run out of food)						.00	-.20**	-.17*	-.02	.10
5. Servings of fruit and vegetables							.37**	.38**	.18	.69**
6. High-fibre self-efficacy	22.9	5.1						.89**	.47**	.26**
7. High-fibre goal formation	5.6	1.5							.43**	.24**
8. High-fibre outcome expectations	6.5	.98								.09
9. Daily fibre gram intake	21.4	15.9								

Study conducted in Edmonton, Alberta in August-September, 2008. † Education scale:(completed some high school to completed graduate school)
Note. *p < .05, **p < .01.

Table 6.4. Bivariate Pearson product-moment correlations among physical activity, social cognitive constructs, and demographic variables

Variable	M	SD	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Age (years)			-.20**	-.09	-.08	-.02	.10	-.02	.12	.00	.07
2. BMI (kg/m^2)				-.11	-.06	-.19**	-.19**	-.22**	-.21**	.01	-.19**
3. Education†					.03	.09	.12	.13	.12	-.01	.12
4. Access	2.5‡	0.9				.03	.06	.06	.01	-.03	.13*
5. PA task efficacy	18.5	8.6					.83**	.76**	.61**	.27**	.42**
6. PA scheduling efficacy	17.4	8.8						.79**	.78**	.31**	.48**
7. PA coping efficacy	14.1	7.7							.62**	.23**	.38**
8. PA goal formation	4.8	1.8								.33**	.45**
9. PA outcome expectations	6.4	1.1									.17*
10. Total PA MET minutes / week	606.0	852.8									

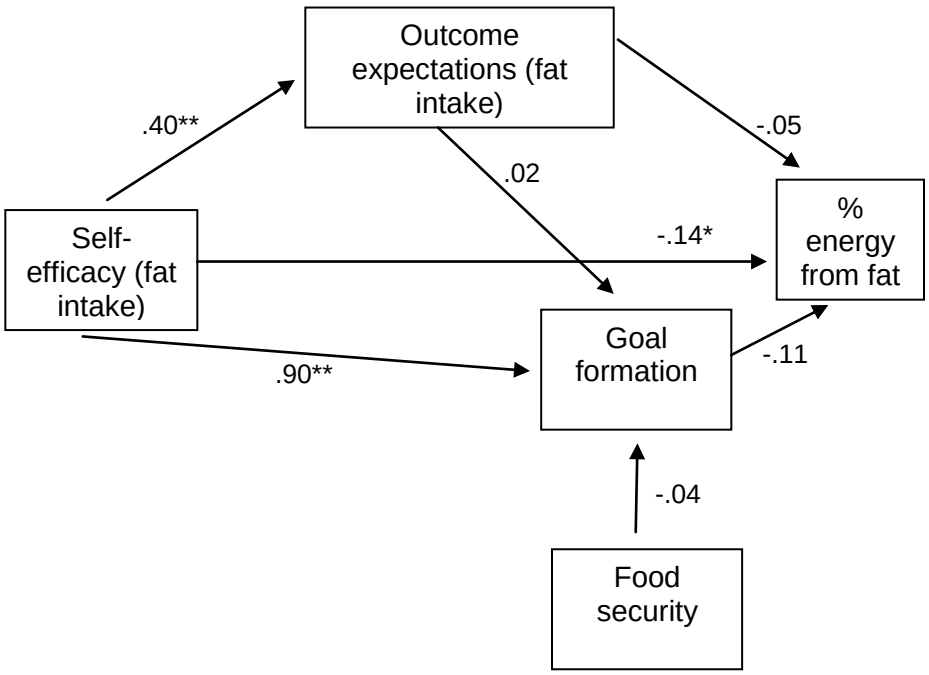
Study conducted in Edmonton, Alberta in August-September, 2008. †Education scale:(completed some high school to completed graduate school)
‡A mean of 2.5 represents a walking distance of 11-30 minutes.
Note. *p < .05, **p < .01.

Table 6.5. R^2 values for fat, fibre and PA path analyses

Behaviors	R^2 behavior	R^2 goal	R^2 outcome expectations
Fat†	.09	.84	.16
Fibre†	.08	.80	.22
Physical activity*			
Coping self-efficacy	.24	.44	.05
Scheduling self-efficacy	.27	.63	.10
Task self-efficacy	.26	.41	.08

† Controlled for age and BMI
*Controlled for BMI

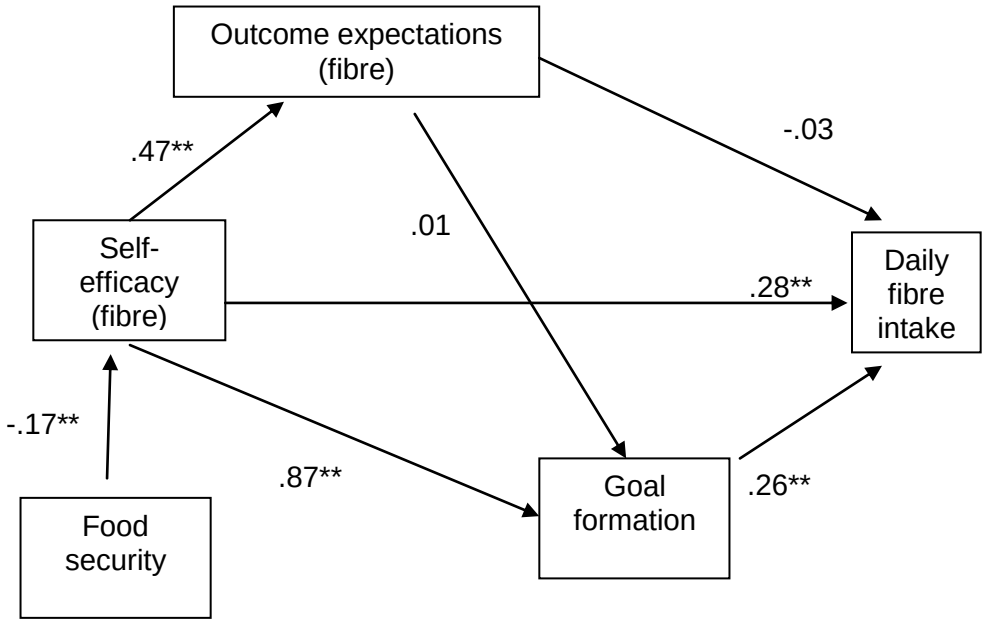
Figure 6.1. Path diagram depicting the relationships between social cognitive theory variables and % energy from fat



Note. *p < .05, **p < .01.

Controlled for age and BMI.

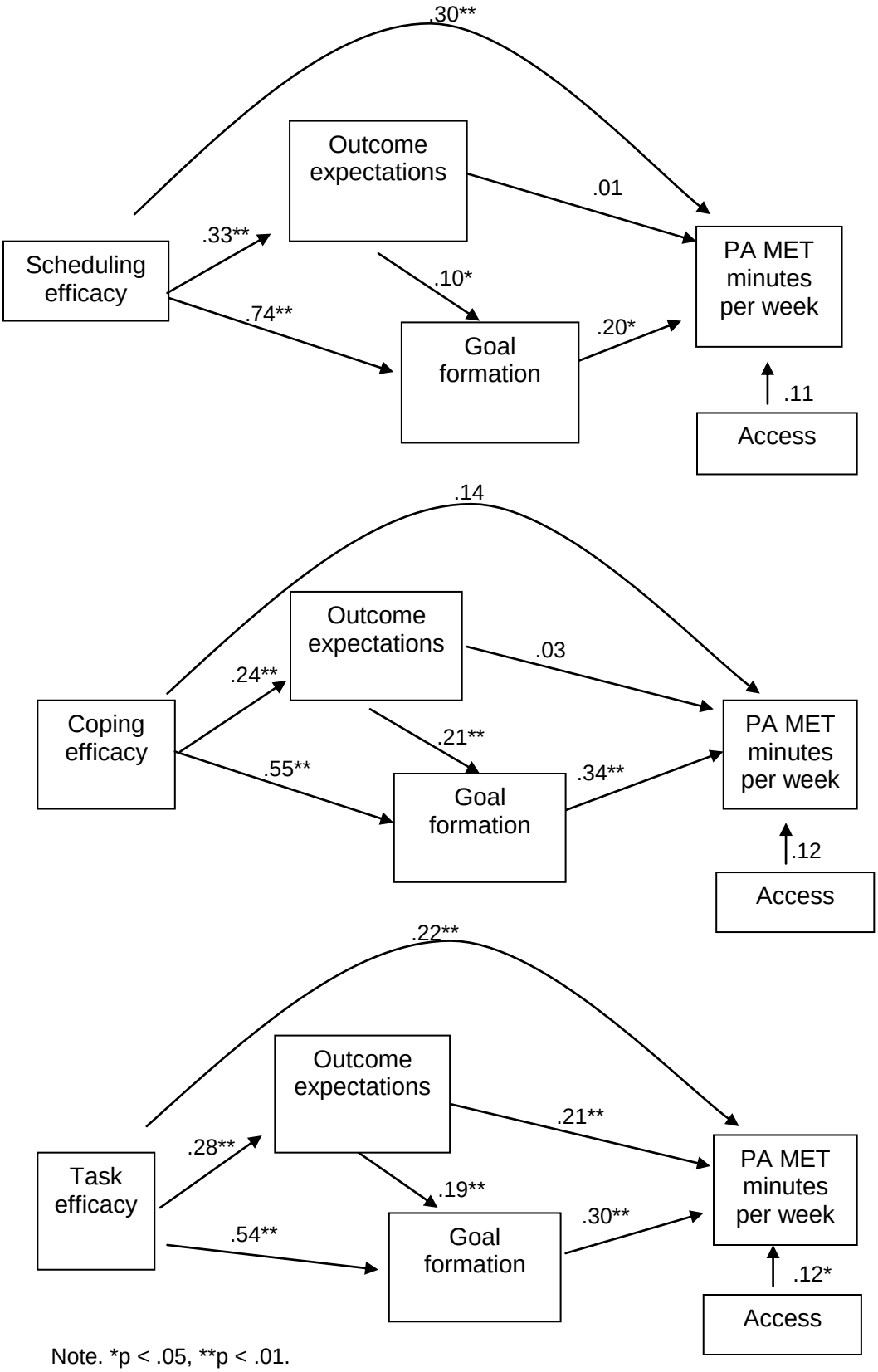
Figure 6.2 Path diagram depicting the relationships between social cognitive theory variables and fibre grams per day



Note. *p < .05, **p < .01.

Controlled for age and BMI

Figure 6.3. Path diagrams depicting the relationships between social cognitive theory variables and PA MET minutes per week



Note. *p < .05, **p < .01.

Controlled for BMI

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CHAPTER 7:

Conclusions

In Canada, the World Health Organization is projecting a 57% rise in prevalence of diabetes by the year 2030 [1]. These projections make the primary prevention of T2D an urgent public health concern [2-4]. Current lifestyle intervention research suggests that approximately 58% of new cases of T2D can be prevented in those individuals with prediabetes over a four-year period or 34-43% of new cases over the long-term [5-9]. People at high risk of T2D include those who are over 45 years of age, are overweight, have a genetic predisposition (family history), have prediabetes, are physically inactive, are members of high-risk ethnic groups, have a history of gestational diabetes or birthing a baby greater than 9 pounds, have cardiovascular risk factors (hypertensive, low LDL cholesterol or high triglyceride levels), have polycystic ovarian syndrome or have a history of vascular disease [10]. Prediabetes describes individuals who have impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) [4]. Thus, without intervention, it is likely individuals with prediabetes will develop T2D [11].

The Canadian Diabetes Association (CDA) has recommended that adults diagnosed with prediabetes receive lifestyle interventions and/or pharmacologic therapy that help prevent the development of T2D, and modify cardiovascular disease risk factors [4]. A national and provincial emphasis on T2D prevention in adults with prediabetes has developed as a result of the documented effectiveness of lifestyle-related behavior change interventions [4, 6, 9, 12-13]. However few U.S. adults with prediabetes are incorporating PA and dietary recommendations into their everyday lives [14]. To date, there is limited Canadian data on optimal and feasible strategies to prevent or delay T2D through obesity treatment and prevention, improved dietary intake and increased physical activity (PA) [15-18].

The primary purpose of this dissertation was to explore prediabetes service provision in order to guide future program development. Two studies were conducted using both qualitative and quantitative approaches to identify factors that may promote effective behavior change in those with prediabetes.

The findings from these studies could be used to guide future research projects that test the efficacy and cost-effectiveness of the identified health promotion framework and compare it to standard practice. Identifying ingredients for T2D prevention programs that promote lifestyle changes within different health care settings has the potential to enhance the current evidence base. Given the importance to public health of preventing or delaying future cases of T2D, such research should be of high priority.

Exploring Prediabetes Service Provision using Grounded Theory

In Chapter 3 (Study 1), Grounded Theory methodology was used to identify and examine the optimal components of a prediabetes intervention program from the perspective of adults with prediabetes, as well as healthcare professionals working with those with prediabetes. In this study, 20 health professionals and 12 adults at high risk of prediabetes were interviewed. Survey data were also collected from individuals with prediabetes (N = 232) residing in Northern Alberta. Relationships between **service provision**, **knowledge or confusion**, **motivational influences**, **goal-setting** and **behavior performance** were described. Ineffective service provision (i.e., service that does not provide education and training on prediabetes for health professionals or a standardized program for people who are diagnosed with prediabetes) leads to low levels of knowledge. This results in high levels of confusion for both health professionals and adults with prediabetes. Confusion and lack of knowledge appear to result in negative beliefs about the importance of behavior change and the importance of

providing intervention to those diagnosed with prediabetes. Those individuals who have negative beliefs also have more perceived barriers to providing prediabetes services (i.e., health care providers) and to changing health behavior (i.e., those with prediabetes). Healthcare providers and organizational structures that do not place importance on prediabetes treatment are not likely to set specific goals to improve service provision or to change health behavior. This results in minimal health behavior change. If and when strategies are implemented to improve service provision, this may likely change the above factors and facilitate health behavior change. Implementation of these strategies may facilitate the awareness of desired health behaviors requiring change to prevent T2D and increase knowledge of current research outcomes and clinical practice guidelines. This results in decreased confusion and leads to more positive beliefs about the importance of intervention in those with prediabetes. Increased knowledge of specific health behaviors to change also increases the ability of adults with prediabetes to problem solve and overcome their perceived barriers. Individuals who have positive beliefs and problem solving ability are able to verbalize specific goals they are doing to try to reduce their risk of T2D. These individuals appear much more likely to perform positive health behaviors that are likely to impact their prediabetes.

Comparing these results with other qualitative research conducted in health professionals providing prediabetes services and in adults with prediabetes identified similar themes across the studies. Evans et al. [19] also identified a lack of knowledge in both health professionals and adults with prediabetes and identified strategies designed to decrease confusion and increase program buy-in from health professionals such as providing key messages at diagnosis and providing additional training to professionals around

clinical practice guidelines for prediabetes and optimal service provision. Wylie et al. [20] interviewed only general practitioners, and similar to Study 1, highlighted a) the lack of awareness present, b) the concerns about workload issues, c) the need for a specific clinical practice guideline, d) the concern that prediabetes is a social problem and not a medical problem, and e) the positive attitudes towards pharmacologic intervention versus pessimism about lifestyle interventions. When Boltri et al. [21] conducted focus groups in community leaders about offering a diabetes prevention program five themes were identified that influence service provision. They included illness perceptions, illness concerns, illness prevention, religion and coping, and program recommendations. Study 1 identified similar themes with the exception of religion and coping. The main barrier identified in the study by Boltri et al. [21] was a lack of knowledge limiting behavior change in those at high risk of T2D which resulted in a lack of interest. This was a recurring theme throughout Study 1. An interesting finding from Andersson et al. [22] was that people with prediabetes were more successful at making behavior changes if they had increased awareness about the disease and knew what they could specifically do to reduce their risk. Further, they were more successful if they also accepted personal responsibility for the outcome of their disease and set attainable behavior change goals. Barriers to change in this study included seeing the new behaviors as not pleasurable and as a loss of liberty to eat and do what they want and decreased self-efficacy from failed attempts at change. Study 1 also identified these beliefs as inhibiting behavior change. Troughton et al. [23] reported high levels of confusion in people with prediabetes, particularly in regards to the differences between T2D and prediabetes. Strategies to address confusion included increasing knowledge about preventive action, providing follow-up, providing written information, and providing support for change.

The results from Study 1 corroborate the themes identified in other qualitative research examining participants' experiences with prediabetes. This study developed a theory grounded in the data which described how these themes influenced behavior which then facilitated the generation of a detailed list of strategies organizations may find beneficial to include in their prediabetes programs. Through the examination of these recommendations and considering their context, health care organizations may be able to better provide prediabetes programs that increase PA and dietary behavior change and increase health professional support for these services. However, future research conducted in community intervention trials may determine if application of these strategies results in improved outcomes.

Physical Activity Behavior and Health-Related Quality of Life

In Chapter 4 (Study 2), we examined differences in health-related quality of life (HRQoL) (i.e., physical and mental functioning) between individuals with prediabetes who are physically active compared to those who are inactive (i.e., meeting and not meeting PA guidelines). In support of our hypotheses, we reported individuals with prediabetes who were physically active had significantly higher mean scores on physical and mental health composite items from the RAND-12 compared to inactive individuals with prediabetes. These results suggest that meeting PA guidelines is associated with better physical and mental functioning among people with prediabetes.

Further, Study 2 is the first Canadian study to report the PA prevalence rate of individuals with prediabetes. This study indicated that 38% of participants reported achieving PA guidelines. This estimate is slightly lower than general population estimates [24]. However, this finding is not surprising given the

characteristic nature of this sample which was heavier (i.e., mean BMI = 31.2), older, included a greater proportion of females, and had greater numbers of comorbidities than the general population. Expressed differently, median moderate- and vigorous-intensity PA weekly MET.min were 240 MET.min/week (Interquartile Range = 0-975.0), a value that is much lower than the current PA guidelines of 600 MET.min/week [25], and lower than other research studies examining individuals with prediabetes [6, 26]. However, these differences could be influenced by the different methods in which self-report PA were measured.

Our sample of individuals with prediabetes in general reported lower HRQoL than the general population. Specifically, in our sample 31.6% reported a low score on the PHC compared to U.S. normative sample data of 19.8% reporting a low score [27]. On the PHC, 30.5% reported a high score in our sample while 45.8% of the U.S. sample reported a high score [27]. For the MHC, in our sample, 27.1% scored low while 14.4% of the U.S. sample scored low [27]. A high score on the MHC was obtained by 22.6% of our sample while 46.8% of the U.S. sample scored high [27]. These results indicate that adults with prediabetes report lower physical and mental functioning.

Given the paucity of studies examining PA behavior and HRQoL in individuals with prediabetes, comparing these results with others is challenging. Our data, along with reported low PA participation rates among individuals with prediabetes suggest that PA levels will remain low unless attempts are made to promote and encourage PA in this population. The positive associations that emerged between PA and HRQoL do provide a rationale for developing and evaluating PA interventions for individuals with prediabetes. Such interventions may result in an improvement in the HRQoL (and perhaps other psychosocial health outcomes) of those individuals living with prediabetes; however this

hypothesized relationship needs to be examined in future randomized controlled trials.

Physical Activity Preferences of Individuals with Prediabetes

Chapter 5 (Study 3) of this dissertation presents the PA preferences of this sample of individuals with prediabetes. Further, this study demonstrates the relationship between demographic, health, and PA variables and their influence on individuals' PA preferences. The majority of individuals with prediabetes would like to receive PA counseling (75%), were able to participate in a PA program (96%), and were interested in participating in PA programs (86%) for individuals with prediabetes. Further, various demographic (i.e. gender, employment, income, marital status, education and age), health (i.e., BMI, comorbidities, time since diagnosis) and PA behavior characteristics (i.e., those meeting and not meeting guidelines) were associated with specific PA preferences in this sample of individuals with prediabetes. These findings were consistent with other research studies examining special populations, in particular, cancer survivors [28-31].

Not surprisingly, the majority of individuals in our study indicated they would be most interested in walking (71%). The next most popular activities were sport-related activities (31.5%), swimming (31.5%), resistance training (22.9%), and cycling (20.3%). These results are exciting given the large body of evidence indicating that moderate-intensity activities (e.g., brisk walking) have an effective role in the prevention of T2D. Indeed, the American College of Sports Medicine [32] has suggested that PA programs should emphasize activities such as walking, given the health-related benefits associated with walking, and ease of access in which these types of activities can be performed.

The findings from this study have implications for program planning. Specifically, clinicians and practitioners need to be aware of their patients' PA behavior profile prior to offering counseling about PA. For example, individuals who were already active were less likely to be interested in receiving PA counseling and it may be a waste of limited resources discussing PA when they are already active enough to improve their health. In addition, it appears prediabetes programs would benefit from offering different PA options (e.g. mild and moderate activities or home-based and gym-based PA) in order to promote increased participation in PA. Examining PA preferences and factors related to PA preferences can facilitate the initiation and maintenance of PA, and aid clinicians (e.g., dietitians), practitioners (e.g., physicians), and program planners (e.g., YMCA leaders) to develop intervention tools, programs and strategies that appeal to individuals with prediabetes and encourage participation and engagement [33]. Utilizing this knowledge may add to the PA recommendation knowledge base as well as tailoring PA interventions designed for individuals with prediabetes.

Social Cognitive Determinants of Physical Activity and Fat and Fibre Intake

Chapter 6 (Study 4) presents relationships between constructs from social cognitive theory (SCT) and PA and fat and fibre intake in this sample of individuals with prediabetes. Examining dietary intake in this sample demonstrated a mean percent calories from fat that met current recommended intakes; however, mean fibre intakes and mean fruit and vegetable intakes were lower than accepted public health guidelines. For both fat and fibre intake, self-efficacy had significant effects on outcome expectations, goal formation and dietary intake. In the fibre model, food security had a direct effect on self-efficacy for eating a high-fibre diet. For PA MET.min/wk, scheduling, coping and task

efficacy had significant effects on outcome expectations, and goal formation. Scheduling and task efficacy both had significant effects on PA. Goal formation had a direct effect on PA for scheduling, coping and task efficacy and outcome expectations had a direct effect on goal formation. Overall, SCT appeared to be a useful model for examining PA and fat and fibre intake in individuals with prediabetes.

This is the first study to examine SCT constructs in a sample of adults with prediabetes. We can, however, compare our results to data from SCT research in other populations. A review of SCT variables and PA behavior in individuals with T2D [34] found statistically significant relationships between self-efficacy and PA. This review as well as others have found mixed results for associations between outcome expectancies and PA [34-35], which is consistent with our findings. Our data suggest scheduling, coping and task efficacy may be an important determinant of PA in our study participants. Scheduling and task efficacy may influence PA either directly, or via facilitating the formation of goals, which may then influence PA. Our results support that coping efficacy appears to influence PA through the formation of goals.

Both our study and a recent one by Anderson and colleagues [36] reported significant relationships between higher levels of self-efficacy and lower fat and higher fibre intake. The role of outcomes expectations in predicting fat and fibre intake was also similar as outcome expectations did not appear to have any effect on fat or fibre intake in our study or the study by Anderson et al. [36]. These findings provide further evidence that the self-efficacy construct is likely an important determinant of PA, fat and fibre intake in the prediabetes population.

Overall, the SCT framework predicted some of the variance in PA, and fat and fibre intake. Our data suggests that SCT-based strategies (either

interventions or programs) to facilitate PA, fibre intake, and reduce fat intake should focus on building self-efficacy and promoting goal formation for each respective health behavior. Intervention research in other populations suggests a critical role for SCT and self-efficacy in the PA and nutrition domain [36-39]. Indeed, some researchers have contended that the effects of self-efficacy on health behaviors are stronger than psychosocial determinants found in other theoretical models [40-41]. Ultimately, incorporating a theoretical approach based on behavioral theory into a T2D prevention program may increase the proportion of participants who successfully change their behavior [42-43]. It is through the implementation of behavioral theories (e.g., theory of planned behavior, protection motivation theory, transtheoretical model), and thorough analyses of the potential moderators/mediators of behavior change (i.e., theoretical constructs) that researchers and practitioners can begin to understand how to develop and implement theoretically based programs that maximize opportunities for behavior change [43].

Limitations

Despite the importance and novelty of this dissertation, there are limitations that should be taken into account when interpreting our data and planning future research initiatives for individuals with prediabetes. Given the inherent differences between qualitative and quantitative research methodologies, there are unique limitations associated with the quantitative research phase of this dissertation that should be recognized.

Overall, the primary limitation of the quantitative research is a lack of generalizability or transferability. The quantitative study was conducted in only one health region and all data came from individuals who were involved with the

diabetes prevention program in that region. Therefore, generalizability from one health region of the province to another may not be appropriate if the health care context or population is sufficiently different. Second, recruitment from the prediabetes education class resulted in a convenience sample. Thus, participants may not be a true representation of the prediabetes population as they have been motivated enough to attend a diabetes prevention program. However, this dissertation identified issues for program planning in a population with sufficient resources to seek out education and knowledge.

Third, it should be recognized that only individuals who have successfully changed their behavior or enjoyed the prediabetes education program may have completed and returned the survey. However, the finding that the majority of individuals who responded to the survey were physically inactive, and had poor PA and dietary habits indicates that overall this sample was not a sample that had successfully changed their behavior. Even though only 38% of individuals in this sample were physically active prior to participating in the survey, it is still possible that a selection bias may exist given the transparent purpose of the study and the 23% participation rate. The possible selection bias may affect the scope in which the results from this study can be generalized. This finding underscores the importance in attracting individuals with prediabetes that are less inclined to participate in research endeavors of a similar nature.

Finally, the self-report nature of the measures for PA and dietary intake should be recognized as a potential limitation There is a body of research identifying multiple influences on individuals' responses on survey instruments that limit their reflection of reality [44]. For example, the integrity of the data may be compromised as individuals may over or under report PA and dietary intake [45]. However, the likelihood that self-report or social desirability bias affected

responses on the self-report PA questions is small as recent research has suggested there is minimal evidence of social desirability for the self-report PA scale that we used [46]. In addition, participants may not have had a suitable understanding and comprehension of the survey items in the same way. Indeed, participant ratings may differ to varying degrees based on participants' perceptions and cognitive processes [44]. However, measures were taken to avoid participant misunderstanding and confusion from impacting the data. Specifically, readability analyses and subsequent modifications along with a pilot phase of the survey for feedback (i.e., to experts as well as those with prediabetes) were conducted prior to administering the survey. Despite the limitations of survey methodology, the benefits of using a survey to collect data include reaching a large population base, time and cost savings for the researcher, minimal participant burden, and it affords confidentiality and is completely anonymous.

There are important limitations to the qualitative phase of this dissertation that also deserve mention. First, although chosen using the principles of theoretical sampling, the small sample of adults with prediabetes did not include many racially diverse individuals. Therefore, the transferability of our results to other ethnic groups may be limited. Other studies conducted in similar samples of adults with prediabetes and health professionals identified similar themes to our research and this strengthens the transferability of the theory [19-20, 22-23]. For the adults with prediabetes, all data were analyzed and discussed by two researchers to minimize individual bias. However, it was not possible to recruit a sample of adults for a focus group to discuss the final results and their applicability to the participants. For the health professional interviews, open coding was done by only the primary researcher but concepts and their

relationships to other concepts were discussed and developed in consultation with other more experienced qualitative researchers.

Strengths

Despite the above-mentioned limitations of the research, there are several important strengths that deserve mention. This dissertation appears to be one of the first attempts to examine PA and fat and fibre intake in a sample of individuals with prediabetes using both qualitative and quantitative approaches. Further, this dissertation appears to be one of the first studies to explore factors related to these behaviors. The findings from this study are important as they warrant future research inquiries and provide valuable information on the design of optimal programs that effectively target the relevant determinants of PA and fat and fibre intake in this population.

There are several strengths to using Grounded Theory as described by Strauss and Corbin [47]. Primarily, a Grounded Theory approach was ideal as no other program development theories have been systematically defined to improve behavior change in diabetes prevention programs. Using Grounded Theory methodology allowed for a richness in data collection that was not possible from the survey. In Grounded Theory, experiences that might otherwise be missed in a survey are included in the data analysis. For example, data collection and analyses were based on participants' own experiences and compared the different beliefs of health professionals and adults diagnosed with prediabetes. This also allowed for a *common language* that research participants from a variety of backgrounds could discuss and provide feedback on.

Implications for Program Planning

When designing an intervention, a program planning model provides structure and guidance on how to identify optimal intervention strategies [48].

Therefore, the Precede portion of the Precede-Proceed model [49] (see Figure 2.1) was used in the initial stages of this research project to guide the assessment of different levels of influence and factors that impact the target behaviors. It is important to note that, though the visual representation of the Precede-Proceed model demonstrates causal relationships, the results from this dissertation are associations. More research needs to be conducted in prediabetes populations to determine if the associations identified in this dissertation are causal.

Social assessment

After exploring HRQoL, as advised by the social assessment portion of the Precede model, lower physical and mental HRQoL in study participants with prediabetes was identified. In addition, people who were active had significantly higher levels of HRQoL than people who were inactive. All four of the studies included in this dissertation identified social and programming concerns of both health professionals and those with prediabetes.

Epidemiological assessment

The epidemiological assessment identified that participants with prediabetes reported lower levels of PA than the general population, and were not meeting fibre and fruit and vegetable intake public health guidelines. Approximately 86% of the survey sample reported being overweight (27%) or obese (59%). Body mass index (BMI) was significantly correlated with PA and fat intake but was not significantly correlated with fibre intake. Employment, BMI, marital status and how long people had been diagnosed with prediabetes all affected PA programming preferences. Approximately 89% of participants reported not smoking and 11% reported smoking daily or occasionally. Only 12% of the sample reported a cultural heritage other than Caucasian, and 11% of

these people would be considered at high-risk of prediabetes. Interestingly, as participants aged they reported a significantly greater number of comorbidities. In terms of accessing care for prediabetes, the adults surveyed report no problems accessing medical care for their prediabetes (92% had no trouble) but only half of them (47%) actually visited a medical professional to discuss their prediabetes in the last year.

Educational and ecological assessment

The educational and ecological assessment identified knowledge levels are low in both adults with prediabetes and the health professionals involved in Study 1. Study 1 was also able to identify different attitudes and beliefs of participants including the important role support from others, including health professionals, plays to promote behavior change in those with prediabetes. Study 2, 3, and 4 further explored the impact cognitive constructs have on PA, and fat and fibre intake. The importance of self-monitoring, goal-setting and offering programs in community settings were all identified in Studies 1-4. The importance of an ecological approach was also discussed in Study 1 as *societal change*.

Comparison to the expanded chronic care model

Comparing the results from this research program to the expanded Chronic Care Model (CCM) may provide further insight into offering efficacious prediabetes programs. The expanded CCM provides a general guiding framework organizations can use in developing their health care system but it does not give specific methods tailored to individual systems to improve outcomes. The findings from Study 1 identified a number of strategies that provide specific detail of how to apply principles from the expanded CCM to prediabetes service provision. These include providing an education program for both health professionals and adults with prediabetes, including the use of

interdisciplinary teams and an evaluation program, incorporating an electronic charting system, designing the prediabetes program centrally and disseminating it to the primary care networks and promoting societal change. Studies 2-4 identified current PA and dietary behaviors, HRQoL, PA program and counseling preferences and significant relationships between SCT constructs and PA and dietary behavior. Based on the findings of these research studies, I outline considerations for program planners and researchers interested in potentially increasing behavior change in prediabetes programs in the following sections; these recommendations are based on the findings of this dissertation and need to be tested in community interventions or randomized controlled trials to determine their efficacy.

The expanded CCM identifies the importance of support from senior leadership to foster an organizational culture that promotes high quality care. Applying this to prediabetes programs within primary care networks, participants in Study 1 felt it was important to have organizational support by designing the program and materials from a central authority and then disseminate the program for implementation. This communicates support and provides direction for the incorporation of additional components from the expanded CCM [50]. In addition, Study 1 identified the need for a formalized evaluation to be incorporated into any prediabetes programming. This would promote higher quality care as advised by the CCM and track program success. Using the RE-AIM framework to determine the program's reach, effectiveness, adoption, implementation and maintenance by the primary care networks may result in increased public health impact and help improve cost-effectiveness [51].

The second component of the CCM, *design of the delivery system*, relates to the design of the prediabetes program. This would include providing

key messages at diagnosis, providing an education class that is personally and culturally relevant, and designing a follow-up protocol (at least monthly for the first year) using a variety of modalities (e.g., telephone calls, internet education class, emails, family doctor and educational DVDs). This would also include clear delineation of the different health professionals roles in the prediabetes program such as those suggested in Study 1. For example, it was suggested the primary care physician provide screening, information at diagnosis, referrals for further services, and monitoring at yearly medicals. It was further suggested that nurses, dietitians and exercise specialists provide further education, support for behavior change, and follow-up. Study 1 also identified that any new program needs to consider and discuss resource utilization with the health professionals offering the program to increase their buy-in. The CCM also suggests incorporating a system of communication that would allow for group management of complex patients within the primary care team [52].

The third component of the CCM, *decision support*, refers to how a healthcare organization provides care that is consistent with scientific evidence as well as health professional and patient preferences [52-53]. The findings of Study 3 highlight the importance of determining PA preferences and behavior prior to program planning or PA counseling using an exercise preferences scale [30] to provide options for PA that are consistent with patient preferences. Study 2 identified lower levels of physical and mental functioning (i.e., HRQoL) in those with prediabetes. Therefore, it may be beneficial for organizations to incorporate mental health services such as depression screening and access to counseling services into their prediabetes programs. In addition, Study 1 identified the importance of providing education to health professionals involved in prediabetes care to decrease confusion and increase awareness of current prediabetes

research, promote the use of clinical practice guidelines, and increase positive attitudes towards prediabetes programming.

Incorporating *clinical information systems,* a component of the CCM*,* such as an electronic chart and tracking system into a prediabetes program was identified in Study 1 as an important strategy to increase the effectiveness of prediabetes programs. The electronic chart can be used to remind primary care physicians to screen for prediabetes and ensure people are getting connected with community resources and additional services. The electronic chart can also be used to track demographic information, health-related behaviors and health and social information [53]. This would be valuable to track health-related quality of life in those with prediabetes and see if it improves if behavior change is successful. For example, while Study 2 identified that HRQoL is higher in adults with prediabetes who are physically active, it is unknown whether or not people who increase their activity will report an improvement in their HRQoL.

The fifth component of the expanded CCM, includes incorporating activities to develop personal skills and a person's ability to self-manage their chronic disease [52-53]. In Study 1, a number of barriers and facilitators to behavior change were identified in those individuals with prediabetes. For example, in order to develop personal skills, an education program has to first identify what individuals need to improve and then provide information that is specific and personalized, addresses strategies to overcome barriers, and incorporates self-monitoring and goal-setting. In addition, Study 4 identified that incorporating SCT into a prediabetes intervention may enhance success; particularly targeting self-efficacy and goal formation for PA and fat and fibre intake. To increase personal efficacy (i.e., belief in your ability to carry out the activity) and self-regulatory efficacy (i.e., belief that you can be successful in the

face of impediments such as increasing PA even when you are too busy, tired or dejected) a number of recommendations have been provided by Bandura [54]; personal mastery encourages people to be successful at progressively more difficult tasks; modeling occurs when other patients or people demonstrate how they have coped with barriers and set-backs to behavior change; persuasive messages focusing on health benefits, increasing positive emotions, that success usually occurs after many failed attempts and encouraging people they have what it takes to succeed and telling them specifically the actions they need to take to succeed; and goal-setting encourages participants to set both proximal and distal goals for behavior change. These techniques to increase self-efficacy outlined by Bandura [54] were identified in Study 1 and Study 4 as potentially increasing the success of a prediabetes prevention program.

The expanded CCM as well as Study 1 both identify the need for societal involvement in promoting healthy behaviors to address prediabetes and obesity. Both identify the need to connect adults with prediabetes to community programs to provide support and offer services (e.g., attending a fitness facility to increase PA, receiving information and support from the Canadian Diabetes Association). While in Study 1 health professionals identified the need for healthy public policies, they felt limited in their ability to advocate for change outside of their organizational structure. The expanded CCM, incorporates building healthy public policy but also includes creating supportive environments for healthy living (e.g., fitness opportunities bring offered at the workplace, healthy choices in vending machines), and strengthening community action by facilitating community groups to promote health in their communities (e.g., walking school bus). To be able to promote societal change, health professionals need to be aware of programs that are within their sphere of influence. For example,

exchanging unhealthy choices such as chips and pop in hospital, schools and workplaces for healthier portion controlled choices such as baked chips, juice and milk. In addition, networking and promoting links between health professionals in primary care networks (e.g., dietitians, nurses) and community health centers (e.g., community dietitians, community health nurses) should be facilitated by management. It is recommended that funding also be available for novel pilot projects promoting PA and healthy dietary intake in communities.

Conclusions

Evidence suggests it is possible to prevent the progression of prediabetes to T2D with small changes in body weight, physical activity levels, and dietary intake. A prediabetes lifestyle education program promoting a 5-10% weight loss, lower intakes of fat (< 35% of calories) and higher intakes of fibre appears warranted in this population. A number of factors significantly related to weight loss, PA and dietary behaviors have been identified. The findings from this dissertation, when incorporated into a program for people with prediabetes, has the potential to enhance the public health impact of prediabetes prevention programs. However, further research is required to determine if the findings of this dissertation will apply successfully within healthcare organizations to enhance behavior change. Given the importance to public health of preventing or delaying future cases of T2D, such research should be a high priority.

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APPENDIX 1:

First health professional interview guide

Briefing:

Thank you for your donating your time and your valuable contribution to the prediabetes study.

- Now that you have read the information letter and consent form, do you have any questions?
- Today, we will be discussing POSSIBLE INTERVENTIONS given to people diagnosed with Impaired Glucose Tolerance, and POSSIBLE BARRIERS THAT EXIST TO CHANGING THEIR BEHAVIOR. There are no right or wrong answers.
- I will be taping the interview, but any information that is provided will be kept confidential. Only my supervisor, and myself, will have access to the tapes. Do you have any questions before we start?

Questions:

1. What is the optimal intervention that should be provided for people diagnosed with IGT? It does not have to be practical.
2. What parts of this intervention do you think are feasible in the current healthcare environment?
3. Within limited healthcare resources, how important do you think it is for CHA to provide more services for people diagnosed with IGT?
4. Who would make up the team to provide education for people diagnosed with IGT?
5. How long after people are diagnosed with IGT should education be provided?
6. In your experience, how often should people diagnosed with IGT receive follow-up with a healthcare professional? For how long? From whom?
7. In your opinion, what should be the goals of a program for people diagnosed with IGT?

8. Is the current program for people diagnosed with IGT adequate to meet the goals that you have identified?
9. What are the barriers for people diagnosed with IGT that prevent them from accomplishing the goals/objectives of the current program?

Debriefing:

- The formal portion of this interview is complete. Do you have any final questions, or points that you would like to make?
- I understand that your main points are: (…). Do you agree with this?

APPENDIX 2:

First prediabetes participant interview guide

Briefing:

- Hi, I am a researcher from the University of Alberta and will be asking you some questions today about your prediabetes.
- Someone from your doctor's office contacted you about talking to me about your experience with prediabetes. Did you have a chance to review and sign the information letter and consent form? Did you have any questions? Would you still like to participate?
- Read to them the purpose of the study from information letter.

Questions:

1. How did you get diagnosed with prediabetes?
2. Why do you think people get prediabetes?
3. Do you feel like prediabetes is a serious disease, why or why not?
4. What type of information or treatment were given when you were diagnosed with prediabetes?
5. Where have you gotten information about prediabetes from?
6. How do you judge whether the information you have received is correct? Is there any particular type of information that seems more correct to you?
7. Is there anything you find confusing about prediabetes...diet...or exercise information?
8. How do you take the information you have about prediabetes and how do you incorporate it into your lifestyle?
9. What do you think are the most important changes you can make to help prevent you from getting Type 2 diabetes?
10. Can you list any things that would help you make these changes?
11. Can you list anything that makes these changes difficult?

12. In your community what type of services do you think should be offered to people with prediabetes?

13. Do you have anything else you would like to add?

Debriefing:

Thank-you for answering my questions today. I really appreciate you taking the time to give me your opinion.

- As a thank-you I would like to get your address and send you a cookbook if you like. What is your mailing address?

APPENDIX 3:
Survey

SECTION 1: PREDIABETES

The questions below ask about prediabetes and diabetes.

PREDIABETES

1. Has a doctor or nurse ever told you that you have **prediabetes, impaired fasting glucose** or **impaired glucose tolerance**?

   ○ YES ○ NO

2. When were you told you have **prediabetes**, **impaired fasting glucose** or **impaired glucose tolerance**?

   Month: _____

   Year: _____

3. Did you attend an education class for **prediabetes, impaired fasting glucose** or **impaired glucose tolerance**?

   ○ YES ○ NO

DIABETES

4. Has a doctor or nurse ever told you that you have **diabetes**?

   ○ YES ○ NO

5. When were you told you have **diabetes**?

   Month: _____

   Year: _____

6. Have you attended an education class for **diabetes**?

   ○ YES ○ NO

SECTION 2: PREDIABETES SERVICES

1. In the past 12 months, did you require a visit to a medical professional to discuss your prediabetes?

O	O
YES	NO

2. What type of medical professional did you visit? Please check all that apply below.

_____Family doctor
_____Walk-in clinic doctor
_____Nurse
_____Dietitian
_____Endocrinologist
_____Other, please write who:_____

3. In the **past 12 months**, did you have any problems getting the medical care you needed for your prediabetes?

O	O
YES	NO

4. **If you answered yes to question 3**, what type of problems did you experience? Please check all that apply below.

_____Difficulty getting an appointment
_____Waited too long - between booking appointment and visit
_____Waited too long - to see the medical professional
_____Transportation problems
_____Language problems
_____Cost
_____Personal or family responsibilities
_____General deterioration of health
_____Appointment cancelled by medical professional
_____Still waiting for visit
_____Unable to leave the house because of a health problem
_____Other, please write the problem here:_____

_____

5. How would you like to receive education about prediabetes? (check all that apply)

_____Over the internet
_____From my family doctor
_____From an educational DVD
_____From an education class
_____Other, please specify here: _____

6. What day of the week would be best for you to attend a prediabetes class? (check only one)

_____Weekday (Monday thru Friday)
_____Weekend (Saturday or Sunday)

7. What would be the best time of day for you to attend a prediabetes class? (check only one)

_____9:00 am to 12:00 pm (noon)
_____1:00 pm to 5:00 pm in the afternoon
_____6:00 pm to 9:00 pm in the evening

8. What would be the best location for you to attend a prediabetes class? (check all that apply)

_____Library
_____Family doctor's office
_____School in community
_____Hospital
_____Community health centre
_____Other, please specify here:_____

9. How did you hear about the prediabetes education class you registered for? (check only one)

_____ Family doctor
_____ Friend or family member
_____ Pharmacist
_____ Community health nurse
_____Other, please specify here:_____

10. Do you think the person teaching a prediabetes class should be: (check all that apply)

_____Someone my own age
_____Someone who is really specific about what I need to change
_____Someone who is male
_____Someone who is female
_____Someone who is from my own culture
_____ A health professional
_____ A trained lay person who has prediabetes

_____ Other, please explain here:_____

11. Would you like follow-up after attending a prediabetes class to help answer your questions and/or encourage you to make health changes?

O YES O NO

If you answered **NO** go to question 12

11. a) If you answered **YES**, what kind of follow-up would you like (check all that apply)?

_____Talking to my family doctor
_____Telephone calls from a health professional
_____Internet education sessions
_____DVD education sessions
_____Emails from a health professional
_____Other, please explain here:_____

11. b) How often would you like to receive follow-up (check only one)?

_____Weekly for the first month then every month
_____Monthly for the first 6 months and then once every 6 months
_____Every month
_____Every 2 weeks
_____Other, please explain here:_____

SECTION 3: QUALITY OF LIFE

This next section asks for your views about your health. This information will help tell us how you feel and how well you are able to do your usual activities.

Answer every question by marking your best answer.

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

○	○	○	○	○
Excellent	Very good	Good	Fair	Poor

2. The following are activities you might do during a typical day. Does *your health now limit you* in these activities?

   Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?

○	○	○
Yes, limited a lot	Yes, limited a little	No, not limited at all

   Climbing **several** flights of stairs?

○	○	○
Yes, limited a lot	Yes, limited a little	No, not limited at all

   Walking **more than a mile/kilometre**?

○	○	○
Yes, limited a lot	Yes, limited a little	No, not limited at all

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

   a. **Accomplished less** than you would like?

○	○
YES	NO

   b. Were limited in the **kind** of work or other activities that you could do?

○	○
YES	NO

4. These questions are about how you have been feeling **during the past month**. 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 month:**

a. Have you felt calm and peaceful?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
O	O	O	O	O	O

b. Did you have a lot of energy?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
O	O	O	O	O	O

c. Have you felt downhearted and blue?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
O	O	O	O	O	O

5. During the **past month**, 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)?

a. **Did you accomplish less** than you would like?

YES	NO
O	O

b. Didn't do work or other activities as **carefully** as usual?

YES	NO
O	O

6. During the **past month**, how much of the time has your **physical health or any 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
O	O	O	O	O

7. During the **past month**, 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

SECTION 4: PHYSICAL ACTIVITY

We would now like you to recall your average weekly physical activity over the past month.

Think of an average week in the past month. How many times (sessions) and for how long did you do the following kinds of activity?

Only count sessions that were for more than 10 minutes and were during your free time.

Please:

- Only count physical activity sessions that lasted **10 minutes or longer**.
- Do not count physical activity like housework or activity done at work.
- **If you have not performed any physical activity, please write '0' in that space.**

In an average week my physical activity is:

	Times a week	**Average length of session**
a. Strenuous physical activity (heart beats rapidly, sweating) (e.g., aerobics classes, jogging, swimming laps, hard bicycling, singles tennis, soccer)	_____	_____minutes
b. Moderate physical activity (not exhausting, light sweating) (e.g., brisk walking, doubles tennis, easy bicycling, pilates, yoga, easy swimming, popular and folk dancing, golf without a cart)	_____	_____minutes
c. Mild physical activity (minimal effort, no sweating) (e.g., easy walking, bowling, lawn bowling, shuffleboard, golf with a cart)	_____	_____minutes

The next questions are about walking.

We are interested in finding out about the different kinds of walking that you do as part of your everyday life. The following questions are about the walking you did in the last 7 days (1) at work, (2) getting from place to place, and (3) for recreation, sport, physical activity or leisure.

1. The first question is about the **walking you do at work ONLY**. This includes paid jobs and other unpaid work you do outside of your home. Do not include unpaid work you do at home such as housework.

During the last 7 days on how many days did you walk for at least 10 minutes at a time as part of your work?

_____ **days per week** OR ☐ **None --- go to question 2**

How much time did you usually spend **on ONE of those days** walking from place to place?

_____**hours** _____ **minutes per day.**

2. This question is about **walking you do to travel from place to place ONLY**, including walking to and from places like work, stores, movie stores, coffee shops and so on.

During the last 7 days on how many days did you walk for at least 10 minutes at a time to go from place to place?

_____**days per week** **OR** ☐ **None** --- go to question 3

How much time did you usually spend **on ONE of those days** walking from place to place?

_____**hours** _____ **minutes per day.**

3. This question is about walking **you do for recreation, sport, physical activity or leisure ONLY.** This does **NOT** include walking you do to get from one place to another, like walking from home to a movie store or from work to a coffee shop.

Not counting any walking you have already mentioned, during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time?

_____ **days per week** **OR** **None** ☐

How much time did you usually spend on **ONE of those days** walking in your leisure time?

_____**hours** _____**minutes per day.**

SECTION 5: PHYSICAL ACTIVITY PREFERENCES

The next set of questions ask about how you would like to learn about physical activity. Mark only one answer for each question.

1. Would you like to be counseled about physical activity at some point?

O	O	O
YES	NO	MAYBE

2. Are you physically able to participate in a physical activity program designed for persons with prediabetes?

O	O	O
YES	NO	MAYBE

3. Would you be interested in a physical activity program designed for persons with prediabetes?

O	O	O
YES	NO	MAYBE

4. What types of physical activity are you most interested in doing?

1. _____

2._____

3._____

5. If you were to participate in physical activity every day, would you prefer to be physically active:

O	O	O	O	O
Alone	With other people with prediabetes	With friends	With family	No preference

O	O	O	O
At home	At a community fitness center	At a hospital program	No preference

O	O	O	O
In the morning	In the afternoon	In the evening	No preference

6. If I could do physical activity every day, I would like my physical activity to be: (check only one line for each group of questions below)

a. _____ low intensity (minimal effort, no sweating)

_____ moderate intensity (not exhausting, light sweating)

_____ high intensity (heart beats rapidly, sweating)

_____ no preference

b. _____ the same activity each session

_____ different activities each session

c. _____ supervised/ instructed

_____ unsupervised/self-paced

d. _____ spontaneous/ flexible

_____ scheduled (specific days and times)

SECTION 5: EATING

Please think about what you **usually** ate or drank during the **past month**, that is, the past 30 days. Please read each question carefully and:

1. Report how many times each day, each week, or each month you ate each food.
2. Choose the best answer for each question.
3. Mark only one answer for each question.

1. How many times per **day**, **week** or **month** did you **usually** eat **cold cereals**?

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

2. How many times per **day**, **week** or **month** did you use **milk**, either to drink or on cereal?

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

2 a. What kind of milk do you **usually** use? (Circle the kind that you used most often).

1. Whole milk
2. 2% fat
3. 1% fat
4. Non-fat or skim
0. DID NOT DRINK MILK IN THE LAST MONTH.

3. How many times per **day**, **week** or **month** did you **usually** eat **bacon or sausage**, not including low fat, light, or turkey varieties?

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

4. How often did you eat **hot dogs** made of beef or pork?

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

5. How often did you eat **whole grain bread** including toast, rolls and in sandwiches? Whole grain breads include whole wheat, rye, oatmeal, and pumpernickel.

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

6. How often did you drink **100% fruit juice** such as orange, grapefruit, apple and grape juice? **Do not** count **fruit drinks or cocktails** such as Kool-Aid, lemonade, cranberry juice cocktail, Sunny Delight®, and Tang®.

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

7. How often did you eat **fruit**? **Count** fresh, frozen, or canned fruit. **Do not count juices**.

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

8. How often did you use **regular fat salad dressing or mayonnaise**, including on salad and sandwiches? **Do not** include low-fat, light or diet dressings.

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

9. How often did you eat **lettuce or green leafy salad**, with or without other vegetables?

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

10. How often did you eat **French fries,** or **hash brown potatoes**?

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

11. How often did you eat **other white, red or yellow potatoes**? **Count** baked potatoes, boiled potatoes, mashed potatoes, and potato salad. **Do not** include yams or sweet potatoes.

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

12. How often did you eat **cooked canned or dried beans**, such as refried beans, baked beans, bean soup, and pork and beans?

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

13. How often did you **usually** eat **other vegetables**?

COUNT: Any form of vegetable – raw, cooked, canned, or frozen.

DO NOT COUNT: Lettuce salads, white potatoes, cooked dried beans, rice or French fries and hash browns

NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day
O	O	O	O	O	O	O	O	O

14. How many times per **day**, **week**, or **month** did you **usually** eat any **kind of pasta**? **Count** spaghetti noodles, macaroni and cheese, pasta salad, rice noodles, soba, and any other kind of pasta.

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

15. How often did you eat **peanuts, walnuts, seeds, or other nuts**? **Do not** include peanut butter.

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

16. How often did you eat **regular fat potato chips, tortilla chips, or corn chips**? **Do not** include low fat chips.

○	○	○	○	○	○	○	○	○
NEVER	1-3 times last month	1-2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 times per day	3 times per day	4 or more times per day

SECTION 7: WEIGHT CONTROL

These next questions ask you about your weight.

1. Overall, what **BEST** describes your experience with your weight?(check **only one** answer below)

_____ I've lost weight and have been able to keep it off.

_____ I've lost weight but haven't been able to keep it off.

_____ I've tried to lose weight but haven't been successful.

_____ I've maintained my weight with conscious effort.

_____I've maintained my weight without effort.

_____I've gained weight and haven't tried to lose it.

_____I pay no attention to my weight.

2. Below are some ideas that people use to lose or maintain their weight. **In the past 12 months**, please check **all of the following** you have tried:

○	Reduce the amount of food you eat
○	Be physically active an average of at least 30 minutes per day
○	Eat more fruits and vegetables
○	Eat reduced calorie products
○	Reduce high carbohydrate foods like bread and potatoes
○	Eat smaller portion sizes
○	Cut out sweetened beverages like pop, sports drinks, or Sunny Delight®
○	Eat reduced-carbohydrate foods
○	Eat reduced-fat foods
○	Count calories
○	Reduce sedentary activities like watching TV or time on the computer
○	Consume over-the-counter diet products like Hydroxycut® or Dexatrim®
○	Reduce the amount of food prepared away from home
○	Consume meal replacement products like Slim-Fast®
○	Incorporate physical activity into daily routines
○	Go to formal weight loss program like Weight Watchers® or Jenny Craig®
○	Keep a food diary
○	Use Internet web-site with a diet program designed for you

3. Please check which of the following, if any, you do **most days of the week**:

○	Track how many calories you eat
○	Track how many carbohydrates you eat
○	Track how many grams of fat you eat
○	Plan your meals and snacks during the day
○	Think about the amount of food you put on your plate
○	Measure the amount of food you put on your plate
○	Eat breakfast

4. How frequently do you weigh yourself?

○	○	○	○	○	○
Every day	Every week	Every month	Every couple of months	Once a year	Never

5. The following is a list of possible reasons that keep people from losing weight or staying at a healthy weight. Please circle below from 1 to 7 how much each reason keeps you from losing weight or staying at a healthy weight.

	No or little influence						**Influences a lot**
I eat away from home too often.	1	2	3	4	5	6	7
I'm often too tired.	1	2	3	4	5	6	7
I like to eat junk food/ have a sweet tooth.	1	2	3	4	5	6	7
I don't have time to be physically active.	1	2	3	4	5	6	7
I don't really pay attention to what I'm eating.	1	2	3	4	5	6	7
I don't have anyone to be physically active with me.	1	2	3	4	5	6	7
Diet or healthy foods are not filling and I still feel hungry.	1	2	3	4	5	6	7
It is hard to stick with a physical activity routine.	1	2	3	4	5	6	7
Diet or healthy foods cost too much.	1	2	3	4	5	6	7

6. Did you try to lose weight after you were told you have prediabetes?

○	○
YES	NO

6. a) If YES, what was your body weight before you tried to lose weight?

Weight: _____pounds, or _____kg

7. Do you ever run out of food before the end of the month?

○	○	○	○
NEVER	Sometimes	Often	Always

8. I expect to <u>lose weight</u> over the next month.

	○	○	○	○	○	○	○	
Definitely do not	1	2	3	4	5	6	7	**Definitely do**

9. How important do you think it is to lose weight to help control your prediabetes?

	○	○	○	○	○	○	○	
Not at all important	1	2	3	4	5	6	7	**Very important**

SECTION 8: BEHAVIOR

Physical Activity

The definition of regular physical activity is:

At least 30 minutes of moderate-intensity physical activity on at least 5 days of the week (e.g., light sweating, some increase in heart rate, and you need to catch your breath when talking).

Over the next month, how confident are you that you can do the following tasks:

	No confidence										**Complete confidence**
Complete your physical activity using the proper technique	0	1	2	3	4	5	6	7	8	9	10
Follow directions to complete physical activity	0	1	2	3	4	5	6	7	8	9	10
Perform all of the required movements	0	1	2	3	4	5	6	7	8	9	10
Be physically active when you feel discomfort	0	1	2	3	4	5	6	7	8	9	10
Be physically active when you lack energy	0	1	2	3	4	5	6	7	8	9	10
Be physically active when you don't feel well	0	1	2	3	4	5	6	7	8	9	10
Include regular physical activity in your daily routine	0	1	2	3	4	5	6	7	8	9	10
Consistently be physically active 5 times per week	0	1	2	3	4	5	6	7	8	9	10
Arrange your schedule to include regular physical activity	0	1	2	3	4	5	6	7	8	9	10

1. I expect to be physically active most days of the week over the next month.

	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7	
Definitely do not								**Definitely do**

2. To what extent do you think being physically active most days of the week for at least 30 minutes a day is important for controlling your prediabetes?

	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	○ 7	
Not at all important								**Very important**

Low-Fat Diet

The following set of questions asks about how sure you are that you can eat a low-fat diet over the next month. Please mark an answer for all the questions below.

We define a low-fat diet as regularly:

- **Choosing vegetables, fruit, and grain products that are lower in fat.**
- **Choosing lower fat milk products (e.g. skim or 1% milk, less than 20% M.F. or B.F. cheese).**
- **Choosing lean meats and preparing them with little added fat (e.g. removing skin from chicken, choosing extra lean ground beef, cooking meat so fat drips off).**
- **Limiting foods and drinks high in fat (e.g. deep-fried food, fast food, butter, hard margarine, milkshakes, baked goods like cake, pastry, pies and cookies).**

1. I believe **I have the ability** to eat a low-fat diet in the next month.

	O	O	O	O	O	O	O	
Definitely do not	1	2	3	4	5	6	7	**Definitely do**

2. **How likely** are you to eat a low-fat diet in the next month?

	O	O	O	O	O	O	O	
Very unlikely to eat a low-fat diet	1	2	3	4	5	6	7	**Very likely to eat a low-fat diet**

3. How sure are you **that you will be able** to eat a low-fat diet in the next month?

	O	O	O	O	O	O	O	
Very unsure	1	2	3	4	5	6	7	**Very sure**

4. If it were entirely up to me, **I am confident** that I would be able to eat a low-fat diet in the next month?

	O	O	O	O	O	O	O	
Strongly Disagree	1	2	3	4	5	6	7	**Strongly Agree**

5. **I expect** to eat a low-fat diet over the next month.

	O	O	O	O	O	O	O	
Definitely do not	1	2	3	4	5	6	7	**Definitely do**

6. How important do you think it is to eat a low-fat diet to help control your prediabetes?

	O	O	O	O	O	O	O	
Not at all important	1	2	3	4	5	6	7	**Very important**

High-fibre questions:

The following set of questions asks about how sure you are that you can eat a high-fibre diet over the next month. Please mark an answer for all the questions below.

We define a high-fibre diet as regularly:

- **Choosing whole grains (e.g. brown rice, whole-wheat bread and pasta, oatmeal, barley) for at least half of the grain products that you eat.**
- **Eating beans and lentils.**
- **Eating cereal or bread that is a "high source of fibre".**
- **Eating at least 7 servings of fruit and vegetables every day (1 serving is 1 medium (1/2 cup) fresh vegetable or fruit, 1 cup of salad, or ¼ cup of dried fruit).**

1. I believe **I have the ability** to eat a high-fibre diet in the next month.

	O	O	O	O	O	O	O	
Definitely do not	1	2	3	4	5	6	7	**Definitely do**

2. **How likely** are you to eat a high-fibre diet in the next month?

	O	O	O	O	O	O	O	
Very unlikely to eat a high-fibre	1	2	3	4	5	6	7	**Very likely to eat a high-fibre diet**

3. How sure are you **that you will be able** to eat a high-fibre diet in the next month?

	O	O	O	O	O	O	O	
Very unsure	1	2	3	4	5	6	7	**Very sure**

4. If it were entirely up to me, **I am confident** that I would be able to eat a high- fibre diet in the next month?

	O	O	O	O	O	O	O	
Strongly Disagree	1	2	3	4	5	6	7	**Strongly Agree**

5. **I expect** to eat a high-fibre diet over the next month.

	O	O	O	O	O	O	O	
Definitely do not	1	2	3	4	5	6	7	**Definitely do**

6. How important do you think it is to eat a high-fibre diet to help control your prediabetes?

	O	O	O	O	O	O	O	
Not at all important	1	2	3	4	5	6	7	**Very important**

Eating Confidence

Please circle below from 0 to 10 how confident you are that you can successfully resist eating over the next month.

I can resist eating:	**Not confident**										**Very confident**
when I am anxious (nervous)	0	1	2	3	4	5	6	7	8	9	10
when I am depressed (or down)	0	1	2	3	4	5	6	7	8	9	10
when I am angry (or irritable)	0	1	2	3	4	5	6	7	8	9	10
when I have experienced failure	0	1	2	3	4	5	6	7	8	9	10
when there are many different kinds of food available	0	1	2	3	4	5	6	7	8	9	10
even when I am at a party	0	1	2	3	4	5	6	7	8	9	10
even when high-calorie foods are available	0	1	2	3	4	5	6	7	8	9	10
even when I have to say “no” to others	0	1	2	3	4	5	6	7	8	9	10
even when I feel it’s impolite to refuse a second helping	0	1	2	3	4	5	6	7	8	9	10
even when others are pressuring me to eat	0	1	2	3	4	5	6	7	8	9	10
even when I think others will be upset if I don’t eat	0	1	2	3	4	5	6	7	8	9	10
when I feel physically run down	0	1	2	3	4	5	6	7	8	9	10
even when I have a headache	0	1	2	3	4	5	6	7	8	9	10
when I am in pain	0	1	2	3	4	5	6	7	8	9	10
when I feel uncomfortable	0	1	2	3	4	5	6	7	8	9	10
when I am watching TV	0	1	2	3	4	5	6	7	8	9	10
when I am reading	0	1	2	3	4	5	6	7	8	9	10
just before going to bed	0	1	2	3	4	5	6	7	8	9	10
when I am happy	0	1	2	3	4	5	6	7	8	9	10
I can control my eating on the weekends	0	1	2	3	4	5	6	7	8	9	10

SECTION 9: NEIGHBOURHOOD ENVIRONMENT

We would like to find out more information about the way that you perceive or think about your neighborhood.

Please mark the answer that best applies to you and your neighborhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

1. Stores are within easy walking distance of my home.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

2. There are many places to go within easy walking distance of my home.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

3. It is easy to walk to a transit stop (bus, train) from my home.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

4. There are major barriers to walking in my local area that make it hard to get from place to place
(for example: freeways, railway lines, rivers, canyons, hillsides).

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

5. There are trees along the streets in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

6. There are many interesting things to look at while walking in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

7. There are many attractive natural sights in my neighborhood (such as landscaping, views).

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

8. There are attractive buildings/homes in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

9. There are sidewalks on most of the streets in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

10. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

11. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

12. My neighborhood streets are well lit at night.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

13. Walkers and bikers on streets in my neighborhood can be easily seen by people in their homes.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

14. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.

Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
O	O	O	O

About how long would it take to get from your home to the <u>nearest</u> businesses or facilities listed below if you <u>walked</u> to them? Please put only <u>one</u> check mark (√) for each business or facility.

	1-5 min	6-10 min	11-20 min	20-30 min	30+ min	don't know
example: gas station	1._____	2._____	3. ✓	4. _____	5. _____	8. _____
1. convenience/ small grocery store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
2. supermarket	1._____	2._____	3. _____	4. _____	5. _____	8. _____
3. hardware store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
4. laundry/dry cleaners	1._____	2._____	3. _____	4. _____	5. _____	8. _____
5. clothing store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
6. post office	1._____	2._____	3. _____	4. _____	5. _____	8. _____
7. library	1._____	2._____	3. _____	4. _____	5. _____	8. _____
8. elementary school	1._____	2._____	3. _____	4. _____	5. _____	8. _____
9. other schools	1._____	2._____	3. _____	4. _____	5. _____	8. _____
10. book store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
11. fast food restaurant	1._____	2._____	3. _____	4. _____	5. _____	8. _____
12. coffee place	1._____	2._____	3. _____	4. _____	5. _____	8. _____
13. bank/credit union	1._____	2._____	3. _____	4. _____	5. _____	8. _____
14. non-fast food restaurant	1._____	2._____	3. _____	4. _____	5. _____	8. _____
15. video store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
16. pharmacy/drug store	1._____	2._____	3. _____	4. _____	5. _____	8. _____
17. salon	1._____	2._____	3. _____	4. _____	5. _____	8. _____
18. your job or school (check here _____if not applicable)	1._____	2._____	3. _____	4. _____	5. _____	8. _____
19. bus or train stop	1._____	2._____	3. _____	4. _____	5. _____	8. _____
20. park	1._____	2._____	3. _____	4. _____	5. _____	8. _____
22. gym or fitness facility	1._____	2._____	3. _____	4. _____	5. _____	8. _____

SECTION 10: INFORMATION ABOUT YOU

This part of the questionnaire is needed to help understand more about you. It is very important information. All your answers will be kept private.

1. Has a doctor or nurse ever told you that you have had the following? Please check all that apply.

a. Angina ____yes ____no

b. Heart attack ____yes ____no

c. Stroke ____yes ____no

d. High blood pressure ____yes ___no

e. High blood cholesterol__yes ____no

f. Other_____

2. I would like to ask your height and weight. If you have a scale, please weigh yourself in the morning and measure your height without shoes and write it down below. Otherwise, please report your last known weight and height:

Height: _____feet _____inches, or _____cm

Weight: _____pounds, or _____kg

3. Do you smoke cigarettes? Please mark your answer below:

O Not at all O Occasionally O Daily

4. What is your cultural background? Please check all that apply.

_____ White
_____ Chinese
_____ South Asian (East Indian, Pakistani, Sri Lankan)
_____ Black
_____ Filipino
_____ Latin American
_____ Southeast Asian (Cambodian, Indonesian, Laotian)
_____ Arab
_____ West Asian (Afghan, Iranian)
_____ Japanese
_____ Korean
_____ Aboriginal (North American Indian, Métis, or Inuit?)

_____ Other (please specify): _____

5. Current marital status (please check):

Never married_____	Married_____	Common law _____
Widowed _____	Divorced_____	Separated _____

6. Education (please check highest level attained):

Some high school	_____	Completed high school	_____
Some university/college	_____	Completed university/college	_____
Some graduate school (e.g., master's degree or PhD)	_____	Completed graduate school	_____

7. Annual family income before taxes (please check):

< 20,000	_____	20-39,999	_____	40-59,999	_____
60-79,999	_____	80-99,999	_____	>100,000	_____

8. Employment status (please check):

I have a disability that prevents me from working	_____	Retired	_____	Part-time	_____
Full-time	_____	Homemaker	_____	Temporarily Unemployed	_____

Would it be possible to contact you for further information regarding your prediabetes? If so, please write a phone number and your name on the lines below:

Name (please print): _____

Phone number: _____

Mailing Address: _____

_____

_____

Is there anything else you would like to tell us? On this final page, please feel free to make any comments about the study, or the prediabetes education class you may have attended. All comments are very helpful to us.

Thank-you very much for being involved in this research project.

Please place the completed survey in the addressed envelope provided.