INCREASING EXERCISE ADHERENCE IN PEOPLE WITH TYPE 2 DIABETES AND PREDIABETES USING SELF-MONITORING STRATEGIES: A FEASIBILITY STUDY

by

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Abstract

Exercise levels in people with prediabetes and type 2 diabetes (T2D) are poor. Exercise can help this population manage their condition by improving blood glucose (BG) regulation for up to 24hr post-exercise. Self-monitoring is a crucial skill for facilitating health behaviour change, and may be particularly relevant for people with prediabetes and T2D as self-monitoring BG can improve many clinically relevant health markers. The impact of self-monitoring BG to improve exercise adherence is not well established. The purpose of this pilot study was to test the efficacy of a self-monitoring group-based intervention using continuous glucose monitors (CGM) at increasing exercise behaviour in individuals with impaired BG.

Thirteen participants with prediabetes or T2D were randomized to an 8-week standard care exercise program (CON; n = 7) or 8-week self-monitoring exercise program (SM; n = 6). Participants in SM were taught how to self-monitor their exercise and BG, goal set, and observe how exercise influences BG using CGM. It was hypothesized that monitoring and being privy to real-time personal BG feedback would facilitate self-monitoring, resulting in greater exercise adherence.

RM ANOVA revealed significant Group x Time interactions for self-monitoring (p < .01), goal-setting (p = .01), and self-efficacy to self-monitor (p = .01), such that participants in the SM condition increased significantly more across the 8-week program and at 1-month follow-up compared to the CON condition. Exercise behaviour was not significantly different between conditions, but medium effect sizes suggest the SM condition had greater increases compared to CON. The SM condition also had significantly higher attendance rates to the exercise program (p = .03), and a significantly greater proportion of participants re-registered for an exercise program (p = .048) compared to CON. Following the exercise program, participants
in both conditions experienced improvements in mental health related quality of life, waist circumference and fitness ($p$’s < .05). Findings suggest self-monitoring is a valuable skill for increasing exercise adherence in people with impaired BG control, and provide initial support for the use of CGM to foster self-monitoring.
Preface

The study idea was conceived by Ms. Kaitlyn Bailey and Dr. Mary Jung. Ms. Bailey was responsible for conducting testing sessions and attending exercise classes, performing data analysis and interpretation, and writing and editing of the thesis. Dr. Mary Jung was responsible for overseeing all aspects of the study, contributing to data interpretation and editing of the thesis. Ethics approval was obtained from the University of British Columbia Clinical Research Ethics Board (H13-00648).
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Chapter 1: Introduction

Scientists have recognized the existence of diabetes for thousands of years (Laios, Karamanou, Saridaki & Androutsos, 2012). Laios and colleagues (2012) report the first recorded portrayal of diabetes described by the Greek physician Aretaeus of Cappadocia during the 2nd century AD. Aretaeus explained that for people living with this disease,

“life is disgusting and painful; thirst, unquenchable; excessive drinking, which, however, is disproportionate to the large quantity of urine, for more urine is passed; and one cannot stop them either from drinking or making water. Or if for a time they abstain from drinking, their mouth becomes parched and their body dry; the viscera seems as if scorched up; they are affected with nausea, restlessness, and a burning thirst; and at no distant term they expire” (Laios et al., 2012).

Since Aretaeus’ time, our understanding of diabetes has improved considerably, and the prevalence of the disease has considerably increased. In 2008/2009 an estimated 2.4 million Canadians had been diagnosed with diabetes (Public Health Agency of Canada, 2011; Warburton, Charlesworth, Ivey, Nettlefold & Bredin, 2010). Type 2 diabetes (T2D), being the most prominent form of diabetes, is a reduction in the production and sensitivity of the body to insulin, resulting in high blood glucose (BG) levels. Prediabetes is a condition characterized by consistently high BG levels, yet not high enough to be considered T2D. Increased attention is currently placed on targeting individuals with prediabetes, as an estimated 70% of people with prediabetes will eventually develop T2D (Tabák, Herder, Rathmann, Brunner & Kivimäki, 2012). The Canadian Diabetes Association estimates close to 9 million Canadians are living with either diabetes or prediabetes—many currently undiagnosed (2012). This is of great concern
because high BG levels, characteristic of T2D and prediabetes, increase risk for heart disease, stroke, hypertension, blindness, kidney and nervous system diseases, amputations, dental disease and pregnancy complications (U. S. Department of Health and Human Services Centers for Disease Control and Prevention, 2011). The value of keeping BG controlled is therefore quite evident and is the aim in most courses of treatment (Schwartz & Scheiner, 2012).

1.1 Benefits of Exercise for People with T2D and Prediabetes

Aerobic exercise provides acute and chronic benefits particularly relevant to people living with T2D or prediabetes. Aerobic exercise, as defined by the Canadian Society for Exercise Physiology, is any activity in which the body’s large muscles move in a rhythmic manner for a sustained period of time and an activity that improves cardiorespiratory fitness (Canadian Society of Exercise Physiology, 2013). Examples of aerobic activities include: walking, running, bicycling and swimming.

1.1.1 Acute benefits

For people with T2D or prediabetes there are numerous acute effects of aerobic exercise that are important in relation to their disease. These include increases in the uptake of glucose into muscles, increases in glucose tolerance and increases in insulin action, all of which lead to better control of BG levels as described in greater detail below (Colberg et al., 2010; Malin, Gerber, Chipkin & Braun, 2011). Furthermore, these benefits derived from a single exercise session can be sustained for up to 72 hours (Boulé et al., 2005; King et al., 1995).

To provide an understanding of the mechanisms through which exercise improves BG control, it is useful to first provide an overview of BG regulation in a healthy individual. When BG concentration increases (e.g., after eating a meal), glucose must be transported from the blood into cells to bring BG back towards homeostatic levels. However, glucose can only freely
diffuse into cells if there are glucose transporter proteins located on the plasma membrane of cells, the most important of these glucose transporter proteins being GLUT4. Translocation of GLUT4 from storage pools in the cytosol toward the plasma membrane is facilitated by the hormone insulin. In a healthy individual, when an increase in BG is detected by the pancreas, insulin is released into the blood stream and binds to receptors on the plasma membrane of insulin-responsive cells. The key insulin-responsive tissues are skeletal muscle, adipose tissue, and liver. Insulin binding to insulin receptors triggers a cascade of events causing the movement of GLUT4 from its intracellular location to the plasma membrane (Goodyear & Kahn, 1998). Once GLUT4 is at the plasma membrane glucose can freely enter cells and BG levels decline back to basal levels (Bell, Burant, Takeda & Gould, 1993).

Poor insulin sensitivity is the hallmark of prediabetes and T2D. In the early stages of pathogenesis insulin is still produced by the pancreas, but it no longer effectively initiates GLUT4 translocation to the plasma membrane; such that despite the same amount of insulin released, there are fewer GLUT4 proteins to allow glucose to enter the cell (Bjornholm, Kawano, Lehtihet & Zierath, 1997). The result of this defect is chronically elevated BG levels, particularly after meals.

As an alternative to insulin, exercise can also lead to increased glucose uptake into the cells (particularly skeletal muscle). Contraction of skeletal muscle triggers the translocation of GLUT4 to the plasma membrane (Douen et al., 1989). This pathway is distinct from the one triggered by insulin (Ploug, Galbo & Richter, 1984; Wallberg-Henriksson & Holloszy, 1985). Therefore, despite the fact that people with T2D or prediabetes have decreased insulin sensitivity, exercise is just as effective in these populations at increasing glucose entry into the cell (Devlin, Hirshman, Horton & Horton, 1987; Kennedy et al., 1999; Martin, Katz & Wahren,
1995; Minuk et al., 1981). With increased transport of glucose out the blood stream, there is a decrease in BG thus bringing BG back towards a healthy range. Exercise, therefore, is a successful method for decreasing BG levels in people with T2D or prediabetes, whom typically have high BG levels due to impaired insulin sensitivity.

As previously stated, improved BG control can be sustained for up to 72 hours post a bout of exercise (Boulé et al., 2005; King et al., 1995). These elevated rates of glucose uptake by cells are believed to be a result of an increase in insulin sensitivity (Holloszy, 2005). Following exercise, the same concentration of insulin released into the blood stream results in greater glucose uptake into cells than it would have without performing the exercise bout (Holloszy, 2005). The underlying mechanisms that cause this increase in insulin sensitivity are still largely unknown but acute exercise-induced increases in insulin sensitivity likely contribute to many of the benefits of physical activity on glucose control (Horowitz, 2007).

1.1.2 Chronic benefits

In addition to acute benefits of exercise, habitual participation in an exercise regimen is associated with further chronic benefits. Participation in regular exercise can improve insulin sensitivity and this is true even after the residual benefits of a single exercise bout on insulin sensitivity have worn off (Henricksen, 2002; Hughes et al., 1993). Hughes and colleagues found that following 12-weeks of exercise training there was significant improvement in insulin action in people with impaired glucose tolerance. By testing participants 96-hours after their last exercise bout Hughes et al. ensured that any acute improvements in insulin action from a single exercise bout would have diminished, therefore confirming that these improvements were a result of training (Hughes et al., 1993). Other chronic benefits include decreases in total cholesterol and blood pressure, reductions in body weight, improvements in body composition,
decreased symptoms of depression and increases in health related quality of life (Colberg et al., 2010). If exercise leads to increases in fitness, this provides even further benefit by decreasing one’s risk of overall mortality as well as cardiovascular-related mortality (Church et al., 2004; Church, LaMonte, Barlow & Blair, 2005). Decreases in cardiovascular-related complications are of particularly high relevance given that cardiac events are the number one cause of death in people with T2D (Grundy et al., 1999).

These acute and chronic benefits of exercise are relevant for both people with prediabetes and people with T2D. However, perhaps one of the most valuable benefits of participation in regular aerobic exercise for people with prediabetes is the prevention or delay of the onset of T2D (Laaksonen et al., 2005; Li et al., 2008; Tuomilehto et al., 2001). Kaye, Folsom, Sprafka, Prineas and Wallace (1991) found that high levels of physical activity reduced the risk of developing T2D by 50% compared to low levels of physical activity. Furthermore, based on results from two randomized controlled trials conducted in people with prediabetes, interventions aiming to increase physical activity levels, in addition to fat reduction, have been shown to decrease the relative risk of developing T2D by 58% (Diabetes Prevention Program Research Group, 2002b; Tuomilehto et al., 2001). One of these trials, the Finnish Diabetes Prevention Study, further found that at the 3-year intervention follow-up period, reduced risk of developing T2D was related to whether participants maintained the physical activity goal of four hours of aerobic activity per week (Lindström et al., 2006).

1.2 Exercise Adherence in People with Type 2 Diabetes and Prediabetes

To achieve the chronic health-related benefits associated with physical activity, Canada’s Physical Activity Guidelines recommends that adults participate in at least 150-minutes of moderate to vigorous activity per week, yet only about 15% of the population is reaching these
levels (Canadian Society for Exercise Physiology, 2011; Statistics Canada, 2013). People with T2D or prediabetes may have even more to gain from exercise regarding management of their disease, yet the percentage of people who are physically active is 19% lower in people with diabetes versus those without diabetes (Morrato, Hill, Wyatt, Ghushchyan & Sullivan, 2007). Equally concerning, 64% of people with prediabetes did not report a single bout of moderate or vigorous exercise lasting for 10-minutes or more when measured over a period of at least two days (Chasens & Yang, 2012).

Despite the extensive amount of exercise trials conducted to demonstrate the physiological benefit of exercise for people with T2D or prediabetes, very few studies have attempted to increase adherence to exercise in this population. The dropout rate following initiation of an exercise program is believed to be as high as 50% in people with T2D (Nam, Dobrosielski & Stewart, 2012). It is therefore prudent that more research be conducted assessing ways to improve exercise adherence in these populations.

1.2.1 Exercise Adherence Interventions in People with Type 2 Diabetes

Meta-analyses of exercise training studies performed in people with T2D found that exercise programs typically involve three days of moderate intensity aerobic exercise per week, lasting on average 18-20 weeks (Boulé, Haddad, Kenny, Wells, & Sigal, 2001; Boulé, Kenny, Haddad, Wells, & Sigal, 2003). Compliance to these exercise programs has been reported as relatively high, with participation rates of 80% or higher in most studies (Boulé et al., 2001; Boulé et al., 2003). However, since these interventions did not attempt to maintain adherence to exercise following cessation of the program, it is not surprising that exercise levels were not assessed following the end of the intervention. Very few studies have attempted to increase
actual independent exercise adherence (i.e., ensuring individuals continue to exercise after exercise programs conclude) in this population.

Walking is the most predominant form of exercise used in exercise interventions for people with T2D (Boulé et al., 2001; Boulé et al., 2003). As a result, there are a handful of interventions that have provided participants with pedometers as a way to track their exercise, possibly increasing their motivation to walk more. One example is an intervention conducted by Tudor-Locke et al. (2004) aimed at increasing physical activity levels in people with diabetes by providing participants with a pedometer and instructing them to walk a specific number of steps per day. They found that although physical activity levels increased in the beginning of the program, there were no significant changes when measured 8-weeks following cessation the intervention (Tudor-Locke et al., 2004). Again this demonstrates the struggle this population faces with adherence to exercise.

One of the largest exercise interventions performed in individuals with T2D was the Look AHEAD trial, which tested the efficacy of a physical activity and diet intervention in a sample of 5,145 participants (Look AHEAD Research Group, 2010). Participants were randomized to a lifestyle intervention condition or a standard education condition. As part of the lifestyle intervention, participants were assigned a goal to engage in 175-minutes of moderate exercise per week (Unick et al., 2011). Participants in this condition were also taught an assortment of behavioural techniques including self-monitoring, goal setting, stimulus control and problem solving to assist them reach their diet and exercise goals (Unick et al., 2011). Participants attended either a group meeting or a counseling session once a week for the first 6 months and then three times a month from months 7 to 12 (Unick et al., 2011). Following the intervention participants were followed up yearly for an additional three years. Directly post-
intervention, participants in the lifestyle intervention condition had significantly increased their physical activity levels from baseline from an average of 863.87 to 1,744.87 kcal/week (Unick et al., 2011). To put this into perspective, for a 100 kg person one hour of moderate exercise is about 400 kcal and one hour of hard exercise is about 600 kcal (Sallis, Haskell, & Wood, 1985). The mean weight of participants in the Look AHEAD trial was 100 kg and therefore once converted this means physical activity levels increased by approximately 131 minutes of moderate activity or 88 minutes of hard activity per week. Physical activity levels were unfortunately not reported for any of the yearly follow-up assessment points. However, at 3-year follow-up participants in the lifestyle intervention condition had significantly greater improvements in fitness compared to the standard education condition, and this improvement in fitness was 5.1% higher than their baseline levels (Look AHEAD Research Group, 2010). This data suggests that the intervention may have been successful at increasing physical activity levels, but without direct assessments of physical activity definite conclusions cannot be drawn.

In addition to the paucity of research that has attempted to increase independent physical activity in individuals with prediabetes or T2D, there are also limited studies that have structured their exercise interventions on theoretical frameworks. Two separate studies tested the effects of an exercise counseling intervention rooted in the Transtheoretical Model (Kirk, Barnett, Leese & Mutrie, 2009; Kirk, Mutrie, MacIntyre & Fisher, 2004). Participants were classified into stages of change (precontemplation, contemplation, preparation, action and maintenance) and depending on their stage, targeted strategies were delivered (Kirk et al., 2009; Kirk et al., 2004). Strategies included identification of the barriers and costs of becoming more active, increasing social support, goal setting, and relapse prevention techniques such as identifying high-risk situations and developing ways to overcome them. In the first study, involving face-to face
counseling sessions, participants self-reported higher levels of moderate intensity exercise from baseline to 12-months, however when measured using an accelerometer there appeared to be no change (Kirk et al., 2004). In the second study the same strategies were used, however delivery of the intervention was randomized to either a face-to-face consultation or providing written material with no researcher contact (Kirk et al., 2009). There were no increases in self-reported physical activity levels or activity measured by accelerometry at 12-month follow-up in either condition (Kirk et al., 2009). In fact, there was a significant decrease in physical activity by 12-month follow-up in both conditions (Kirk et al., 2009).

Di Loreto and colleagues (2003) performed a counseling intervention more successful at changing exercise behaviour guided by principles of Bandura’s Social Cognitive Theory (Bandura, 1986). It focused on boosting self-efficacy, motivation, social support, and teaching participants how to self-monitor and overcome barriers to exercise. During a 30-minute counseling session participants were shown how to plan a step-by-step exercise program (Di Loreto et al., 2003). The counselor suggested different aerobic activities to find the most enjoyable one and suggested participants invite family members to partake in their exercise sessions with them (Di Loreto et al., 2003). Counselors also helped participants find solutions to overcome barriers that may prevent the participant from completing their planned exercise (Di Loreto et al., 2003). For the self-monitoring component, participants were provided with a diary and asked to record the type and times that they performed physical activity (Di Loreto et al., 2003). One month following this initial session participants were contacted via a telephone call to check-in as to whether they were adhering to the physical activity as planned. Thereafter, participants attended appointments with the counselor every three months lasting approximately 15-minutes each. Two years following the initial counseling intervention, 69% of participants
were reaching the exercise guidelines set by the American College of Sports Medicine, a large increase from the mere 3.8% of participants who were meeting these guidelines at baseline (Di Loreto et al., 2003). However, it is unknown whether these improvements in exercise continued once appointments with the counselor were terminated, as this study failed to follow-up with participants after the program concluded.

1.2.1 Exercise Adherence Interventions in People with Prediabetes

Even with the limited amount of research that has been performed in people with T2D, there is even less available that has measured exercise adherence in people with prediabetes. Based upon studies that have, there appears to be similar challenges to adherence as those faced by people with T2D. There are two large trials that have assessed the use of a combined exercise and diet intervention at preventing development of T2D in people with prediabetes (Diabetes Prevention Program Research Group, 2002a; Tuomilehto et al., 2001). The United States Diabetes Prevention Program was a randomized controlled trial comparing a lifestyle intervention targeting exercise and diet with a medicinal intervention at decreasing risk of developing T2D (Diabetes Prevention Program Research Group, 2002a). The goal for the physical activity component of the lifestyle intervention was to increase activity levels to 150-minutes of moderate-to-vigorous exercise per week. Participants in the lifestyle intervention attended 16 individual counseling sessions lasting 30-min to 1-hour as part of an initial intensive intervention phase over the first 24-weeks. They were then contacted monthly for the remaining 6-months. During the intensive phase counselors reviewed likes and dislikes of physical activity with participants and participants were taught how to self-monitor their physical activity. Counselors also discussed how to find time to be physically active, what to do in the event of an injury, basic principles of aerobic exercise, how to determine an appropriate exercise intensity,
and how to stay motivated. Participants were offered voluntary, supervised, physical activity sessions at a community center at least twice per week throughout the entire trial. Following the first 24-weeks, there was a high success rate with 74% of participants reaching the exercise goal. Unfortunately, at the final assessment (on average 2.8 years later), participants reaching the exercise goal had dropped to 58% (Diabetes Prevention Program Research Group, 2002b). The researchers explicitly stated that the study was designed to test the efficacy of a lifestyle change, and therefore frequent contact was enlisted between researcher and participant throughout the duration of the trial (Diabetes Prevention Program Research Group, 2002a). It is unclear whether participants would be able to maintain any physical activity improvements following a period without researcher contact.

The Finnish Diabetes Prevention Trial conducted a similar exercise and diet intervention in people with prediabetes (Lindström et al., 2003). Participants attended seven face-to-face consultations with nutritionists during the first year of the study and then again once every three months for the next two years (Lindström et al., 2003). During these sessions, in addition to dietary counseling, participants were encouraged to increase their overall exercise levels. Walking and hiking groups were arranged and there were two exercise competitions between the five centers involved in the study as a means to increase participants’ motivation to exercise. A control group received general information about lifestyle and diabetes risk. At year one and year three, moderate to vigorous physical activity increased in the lifestyle intervention group relative to the control, thus demonstrating success of the intervention (Lindström et al., 2003). However, similar to the U. S. Diabetes Prevention Program, this intervention was designed to test lifestyle change on health outcomes and therefore even during the maintenance phase of the trial participants were regularly contacted by the researcher.
Overall results from these studies provide varying evidence supporting the success of a behavioural exercise intervention at increasing exercise adherence. Due to follow-up periods ranging from 8 weeks to 3 years it is difficult to compare findings across studies. It appears that interventions including components from the Social Cognitive Theory (Di Loreto et al., 2003) may be more successful than interventions based on other theories (Kirk et al., 2004, Kirk et al., 2009) and non theory-based interventions (Tudor-Locke et al., 2004). The two interventions performed in people with prediabetes (Diabetes Prevention Program Research Group, 2002b, Lindström et al., 2003) had moderate success at increasing exercise adherence. However, without a true ‘no researcher-contact’ follow-up period it is unknown whether participants would maintain exercise levels without regular check-ins from a researcher. Despite the great potential that exercise has for providing health benefits, if people with T2D or prediabetes are unable to maintain a change in their behaviour after cessation of the exercise program, than these programs will be of little long-term assistance.

1.3 Self-regulation

To effectively change behaviour it is important to first understand the principles that regulate behaviour. Some of the first behavioural psychologists compared regulation of human behaviour to a well-oiled machine (Pavlov, 1960). The predominant belief in early psychology was behaviourism, which describes the basis of human behaviour as strictly automatic responses to environmental stimuli. For example, Skinner’s (1938) operant conditioning approach explained the chances of a behaviour reoccurring as depending solely on its consequences, such that favorable consequences would reinforce repetition of behaviour and negative consequences would inhibit future behaviour. Behaviourism portrays the individual as having a primarily passive role in behavioural regulation. Curiously, a vast majority of the experiments at this time
were conducted with non-human subjects (e.g., dogs, rats). Perhaps this is what led these psychologists to overlook what Bandura later identifies as a uniquely human capability: self-regulation of behaviour (1991). For the purposes of this study self-regulation is operationalized as control exerted by the self in order to override a prepotent response and attain one’s goals (Vohs et al., 2008). By the mid-1900’s beliefs regarding the locus of behaviour regulation started to shift from external stimuli to the individual.

Bandura (1977) was among the first to propose that it is through cognitive processes humans are able to regulate their behaviour and that the primary driving force behind behaviour is motivation. He refuted earlier theories by offering the alternative hypothesis that environmental stimuli influence behaviour by acting as cues to allow the individual to predict consequences of the said behaviour. Forward thinking regarding these consequences is what can motivate behaviour. If human behaviour were merely a reactive response to stimuli than people would be constantly shifting to conform to new environments, which is certainly not the case. Bandura (1991) stated that human behaviour is regulated by an interaction between inner and external sources of influence. To help explain this multifaceted relationship Bandura (1986) developed the Social Cognitive Theory (SCT). SCT describes three primary factors that influence behaviour: personal factors (e.g., cognitions and emotions), environmental factors (e.g., aspects of the built and social environment) and behavioural factors (e.g., past behaviour experiences). These factors are believed to interact and affect behaviour, as well as each other, in a reciprocal relationship. The most malleable factor to intervene with is personal factors. SCT identifies five personal factors that impact the initiation and maintenance of behaviour change: knowledge, self-efficacy, outcome expectations, self-regulatory skills and barriers to change (Middleton, Anton & Perri, 2013).
Use of self-regulatory skills is an integral component to adhering to exercise (Schwarzer, 2001; Sniehotta, Scholz & Schwarzer, 2005; Woodgate, Brawley & Weston, 2005). Thus, even with high motivation, behaviour change is challenging without the skills required to self-regulate behaviour.

Self-regulation operates through three main activities: i) monitoring one’s behaviour, its determinants and its effects, ii) assessing one’s behaviour in relation to personal goals, and iii) adjusting one’s behaviour to produce positive outcomes, either tangible or positive self-evaluative reactions (Bandura, 1991). These self-reflective and self-reactive capabilities that people possess are what enable us to exert control over our thoughts, feelings, motivation and actions. However, they are not innate abilities and in many cases must be developed.

Adoption of self-regulatory skills has been demonstrated to be a successful strategy for changing a variety of health behaviours including diet (Armitage, 2004; Baker & Kirschenbaum, 1993; Chapman, Armitage & Norman, 2009), breast self-examination (Luszczynska & Schwarzer, 2003; Orbell, Hodgkins & Sheeran, 1997), and oral hygiene (Sniehotta, Soares & Dombrowski, 2007). From the limited research performed examining exercise adherence in individuals with prediabetes and T2D, it appears that despite the numerous health benefits achieved through exercise, adherence is poor. People with T2D are less physically active and report greater episodes of relapse than their non-diabetic peers (Krug, Haire-Joshu & Heady, 1991, Morrato et al., 2007). A potential reason for the discrepancy is that people with T2D and prediabetes may face more challenges in adopting an exercise regimen than those in the healthy population (e.g., increased fatigue with exercise, necessity to monitor blood glucose levels when exercising, less previous experience with physical activity) and consequently require greater self-regulation to engage in exercise. Without the necessary skills to regulate behaviour, change is
very difficult (Sniehotta, 2009). Bandura (2004) reiterates this point when he argues that merely having a matter of ‘will’ will not result in health behaviour change – instead it requires development of self-regulatory skills.

1.4 Group Mediated Cognitive Behavioural Interventions

Group mediated cognitive behavioural (GMCB) interventions are an approach that have had significant success at increasing exercise adherence rates in people facing extensive barriers to exercise. Coined by Brawley and colleagues, the GMCB method targets behaviour change from a SCT framework and utilizes a group setting to facilitate the change (Brawley, Rejeski & Lutes, 2000; Cramp & Brawley, 2006, 2009; Rejeski, Brawley et al., 2003).

The cognitive-behavioural component of this approach refers to what GMCB interventions target. Guided by SCT, GMCB aims to teach participants self-regulatory skills deemed necessary for adherence to exercise and to provide an opportunity for participants to practice using these skills. Participants are commonly taught how to self-monitor, plan for exercise and how to set exercise-related goals. As well, participants may be provided with tools to assist in learning these skills (e.g., logbook, pedometer). Typically closer to the end of interventions, participants are taught how to overcome exercise-related barriers and lapses. Lastly, participants are encouraged to use self-reinforcement strategies and to reward their exercise successes. Of these skills, self-monitoring may be particularly crucial and relevant to people with prediabetes or T2D, as an essential technique in the management of these conditions is self-monitoring of BG levels. This will be discussed in more detail below.

The second element of GMCB, the group-mediated component, draws from group dynamics research (Cartwright & Zander, 1953). A group setting is used to facilitate learning of cognitive behavioural skills. In the past, teaching in groups has been used for convenience
purposes and to save time. In GMCB, the group setting is specifically targeted as an agent in the intervention of change, primarily by establishing high cohesion among the group. Social processes, motivation and support are utilized to foster a greater commitment to exercise from all group members (Brawley et al., 2000). Common ways group cohesion is developed include creating a strong sense of group identity, creating group goals, and practicing self-regulatory skills together in the group setting. A potential disadvantage of the use of a group setting is the development of dependence on peers within the group. This is avoided in the GMCB model by methodologically transitioning participants from reliance on the group for physical activity to engaging in independent bouts of physical activity. The primary goal of GMCB interventions is to produce independent exercisers, people who eventually engage in exercise long-term without the help of the group or interventionists.

Multiple GMCB-based interventions have shown success at increasing adherence to exercise in a variety of samples. In a study performed in postnatal women, participants who were assigned to the GMCB intervention group reached significantly greater levels of physical activity than those who were in the control group and received a standard exercise program (Cramp & Brawley, 2006, 2009). These higher levels of physical activity were observed following the home-based phase, when participants were exercising on their own for four weeks, thus demonstrating the effectiveness of GMCB to create independent exercisers. Similarly, when incorporating a GMCB framework into an exercise intervention for older adults the GMCB group had a higher frequency of moderate exercise than a standard physical activity program measured at the end of a 3-month period of no contact (Brawley et al., 2000). Lastly, in contrast with a standard of care cardiac rehabilitation program, GMCB resulted in increased long-term adherence to physical activity in a sample either with cardiovascular disease or at risk of
cardiovascular disease (Rejeski et al., 2003). All of these studies show the utility of GMCB interventions at creating independent exercisers in comparison to standard care exercise programs. Learning the skills associated with self-regulation greatly increases success in the maintenance of an exercise regimen, and GMCB demonstrates how groups are a highly effective setting in which to teach these skills.

1.5 Self-monitoring

The skill of self-monitoring is fundamental to self-regulation. Without self-monitoring it is very difficult to act to change or influence one’s behaviour (Bandura, 1991). One of the ways that self-monitoring influences behaviour change is by impacting motivation. Seeing discrepancies in the way one is currently behaving in comparison to personal standards may motivate corrective changes in behaviour (Bandura, 1991). For example, by monitoring exercise levels, it may be made evident that current exercise levels are not congruent with personal goals, leading to increased motivation to exercise more. In this way goal setting is inescapably intertwined with the skill of self-monitoring, as one cannot monitor their activity levels and act to change their behaviour if they do not have a standard with which to judge themselves against (Bandura, 1991).

Self-monitoring may also aid in exercise behaviour change by facilitating the scheduling of exercise. Comparing written self-monitoring records with exercise plans makes it easier to determine if one’s behaviour is consistent with their goals. Self-monitoring allows identification of discrepancies between behaviour and goals, thus providing an opportunity to adjust behaviour by changing one’s schedule. For example, when self-monitoring exercise behaviour, if an individual realizes that they missed a planned exercise bout then they can plan for another time to make up for it in order to still reach their goal. If said person was not self-monitoring then they
may not have been aware that their behaviour was no longer on track to reaching their goal. The formation of implementation intentions is a planning technique that has demonstrated high success at increasing exercise levels (Milne, Orbell & Sheeran, 2002; Prestwich, Lawton & Conner, 2003). Implementation intentions, also known as ‘action plans’ entail writing down exactly where, when and how you are going to perform a behaviour in order to reach your goals (Gollwitzer, 1999). In exercise, creating action plans consists of writing down the specifics of upcoming exercise bouts including the type of exercise and the time and place you intend to do it.

Interestingly, the detail or method associated with self-monitoring does not seem to make a difference; it is simply the process of monitoring one’s behaviour that leads to more successful behaviour change (Helsel, Jakicic & Otto, 2007). Helsel and colleagues found that participants who used an abbreviated form for self-monitoring their diet and exercise levels were more adherent at self-monitoring and lost the same amount of weight as a group using a traditional detailed method of self-monitoring. Not surprisingly, however, frequency of self-monitoring did have an impact, with increased frequency relating to increased weight loss (Helsel et al., 2007).

To ensure continued self-monitoring behaviour, it is important that self-efficacy to self-monitor is high. Self-efficacy beliefs are very powerful in dictating whether one will create intentions, as well as whether they will actually engage in a behaviour (Bandura, 1977). Self-efficacy is defined as one’s perceived ability to perform a specific task. Bandura (1977) outlines four sources for self-efficacy: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal, the most influential of these sources being performance accomplishments. Success at engaging in a behaviour raises performance accomplishments and increases self-efficacy. Therefore, in a self-monitoring intervention it is important to provide
opportunities for participants to experience success at self-monitoring. The second most powerful source of self-efficacy is vicarious experiences. Another strategy therefore for improving self-monitoring self-efficacy is to share accounts of other’s experiences of self-monitoring. It may be effective to lead group discussions surrounding the successes and barriers group members have faced when attempting to self-monitor.

1.5.1 Self-monitoring in exercise interventions

Despite the critical role of self-monitoring in successful self-regulation, few studies have isolated and focused solely on teaching this skill as a means to increase exercise levels. The necessity to self-monitor is prominent in exercise behaviour. A systematic review of physical activity intervention components found that self-monitoring may be one of the most effective techniques for increasing physical activity behaviour (Greaves et al., 2011). One study that sought to use self-monitoring as a strategy to increase physical activity assigned participants to a group that self-monitored their exercise behaviour for 5 days, through the use of a pedometer and activity log, versus a control that received usual care. The group that wore pedometers and self-monitored their physical activity had significantly higher levels of physical activity as assessed 2 to 6 months following the study as compared to the control group (Aittasalo, Miilunpalo, Kukkonen-Harjula & Pasanen, 2006).

1.5.2 Self-monitoring of blood glucose

The skill of self-monitoring may be particularly applicable to people with T2D or prediabetes as self-monitoring of BG is considered a foundation in the management of these conditions. Monitoring BG levels allows for the identification of BG ‘spikes’ and ‘dips’. People with T2D who use insulin can then adjust and refine their insulin dosage to compensate for these ‘spikes’ or ‘dips’. However, it is not just people with T2D using insulin that derive benefit from
monitoring glucose. People with T2D not using insulin or people with prediabetes can still utilize self-monitoring strategies to identify factors that result in high or low BG levels and through lifestyle modifications and possibly medication, attempt to improve regulation. Maintaining steady BG control is vital because it is these more dangerous ‘spikes’ and ‘dips’ that can result in many of the diabetic-related health complications (Stratton, Adler & Holman, 2000). Self-monitoring BG is associated with decreases in diabetes-related morbidity and all-cause mortality both in people receiving insulin therapy and those not (Martin et al., 2006). A systematic review demonstrated that self-monitoring BG also leads to decreases in glycosylated hemoglobin (HbA1c), a clinically relevant health marker describing average BG levels over a period of months (Welschen et al., 2005).

It is speculated here that providing practice with self-monitoring, by self-monitoring BG levels, may develop this skill thus making it easier to learn and master how to self-monitor exercise and vice versa. It is likely that self-monitoring of BG will also increase self-efficacy for all forms of self-monitoring, hence improving self-efficacy to self-monitor exercise. Therefore, teaching self-monitoring of BG to a group of people with impaired BG may coincide well with teaching self-monitoring of exercise.

Traditionally, BG has been monitored using a point-in-time fingertip capillary BG reading. In this process, one uses a lancet to pierce the skin on a finger and forces a drop of blood to appear, from which you can determine BG level using a glucometer. While fingertip BG assessments are highly effective at providing a reading of immediate BG they are painful, and typically taken only four times a day. Therefore they cannot capture the high variability in BG that is common in people with T2D or prediabetes, including many BG ‘spikes’ and ‘dips’. Exercise is highly effective at decreasing variability and blunting the magnitude of these ‘spikes’
and ‘dips’ but again, point-in-time fingertip BG assessments are not able to pick up on these improvements. Fingertip BG assessments have been compared to reading only the first page of each chapter in a novel, a lot of the pertinent information regarding what is going on is lost (Schwartz & Scheiner, 2012). Recently, with the development of a novel technology called continuous glucose monitors (CGM), one can get a full account of BG fluctuation by receiving a constant reading of BG throughout the day. Output from the CGM provides a much more informative depiction of BG control and the variability across a day by displaying updated glucose information every five minutes. CGM are much more successful at capturing the ‘spikes’ and ‘dips’ and changes in them following exercise. Therefore, although self-monitoring of BG using fingertip capillary assessments has been demonstrated to produce improvements in clinical diabetes related markers, it does not effectively capture changes in patterns of BG resulting from lifestyle choices (i.e., diet, exercise). Alternatively, self-monitoring BG using CGM successfully depicts the benefits of exercise for BG control.

1.5.3 Use of continuous glucose monitors (CGM) to self-monitor

Motivation for exercise behaviour is affected by the outcomes people believe and expect their behaviour will produce (i.e., outcome expectancies; Bandura, 2004). People are more likely to adopt a new behaviour, such as exercise, if they associate it with outcome expectancies that they perceive as beneficial and valuable to themselves (Bandura, 2004). Demonstrating the extended benefit that a single bout of exercise has on BG control may resonate strongly in people with T2D or prediabetes, especially if it is paired with information regarding the importance of keeping BG levels controlled. As mastery experience is hypothesized to be the strongest information source to influence self-efficacy, observing these benefits of exercise in oneself is likely to be more powerful than merely being shown hypothetical data. CGM may be very useful
tools in this respect because, when coupled with opportune BG self-monitoring, they can demonstrate the positive effects of exercise on an individual’s own BG control.

To date, only a few studies have attempted to use CGM devices as a means of reinforcing the benefits of exercise for people with T2D. Allen, Jacelon & Chipkin (2009) found that CGMs were quite successful at capturing decreases in BG levels following exercise. Furthermore, following a review of BG graphs participants reported a reinforced commitment towards their exercise regimen. Unfortunately, in this study due to the CGM model utilized participants were blinded to their BG data until the CGM was removed and therefore did not have the opportunity to practice self-monitoring their BG levels. Real-time CGM devices allow the wearer to see, and therefore self-monitor their BG at any given point in the day by displaying it on an external monitor. In a study that utilized real-time CGM for a lifestyle intervention, participants were instructed to adjust their behaviour to counteract BG levels that were too high by increasing their movement and consuming less food (Yoo et al., 2008). Physical activity levels in this group were compared to a group that used the traditional method of finger pricks to monitor their BG. The group wearing the CGM devices had significantly greater increases in physical activity from baseline as compared to the group performing finger pricks. However, the focus of this intervention was on using physical activity merely as a reactive mechanism to adjust BG levels when the CGM indicated that they were too high, and the lasting impact of exercise at better controlling BG levels was not touched upon. It is therefore less likely that their increase in physical activity would sustain once participants were no longer wearing the CGM and receiving signals that their BG was too high. Using real-time CGM instead to teach participants how to self-monitor their BG levels and specifically teaching them how to recognize patterns in BG
following exercise may be a more effective means for increasing exercise and maintaining the increases even after the CGM has been removed.

1.6 The Present Study

The current study tested the feasibility of an 8-week GMCB structured intervention at teaching people with prediabetes and T2D how to self-monitor exercise and BG. BG monitoring was made available to participants by providing them with real-time CGM to wear three times throughout the intervention. In conjunction with self-monitoring, participants were also taught how to set goals. When compared to a standard care exercise program (CON), it is expected that participants in the self-monitoring intervention (SM) would see greater increases in their self-monitoring and goal setting behaviours.

_Hypothesis 1: The SM condition will have greater increases in self-monitoring and goal setting behaviours across time in comparison to the CON condition._

As previously described the most influential source for self-efficacy is performance accomplishments. In the current study, by providing participants in the SM condition mastery experience through the opportunity for guided practice of self-monitoring their exercise and BG behaviour we expect their self-efficacy to self-monitor will increase. Next to performance accomplishments, vicarious experience is the second most influential source for self-efficacy. Participants’ self-efficacy beliefs will also be influenced by vicarious experience during group discussions throughout the intervention regarding participants’ success, difficulties and the strategies they use for self-monitoring. A secondary hypothesis regarding self-efficacy to self-monitor was thus developed.

_Hypothesis 2: The SM condition will have greater increases in self-efficacy to self-monitor in comparison to the CON condition._
To change a health behaviour self-regulatory skills are required (Bandura, 2004). Therefore, it is hypothesized that by teaching participants how to self-monitor and set goals, they will have more success at increasing their exercise levels, will attend more exercise classes and will be more likely to take the next steps to incorporate exercise into their lives, such as re-signing up for an exercise program. Furthermore, it is hypothesized that the extent to which they are self-monitoring and goal setting will directly predict these exercise levels.

**Hypothesis #3:** Exercise levels (including minutes of exercise, frequency of exercise bouts and MET) will increase more in the SM condition in comparison to the CON condition.

This is hypothesized for total exercise and independent exercise (exercise outside of the 8-week physical activity program) and it is hypothesized to hold true immediately post program and at 1-month follow-up.

**Hypothesis #4:** Attendance to the 8-week exercise program will be higher in the SM condition compared to the CON condition and more participants will re-sign up for more exercise classes at the Phoenix Health and Fitness center in the SM condition compared to the CON condition.

**Hypothesis #5:** Self-monitoring and goal setting scores measured during week 7 will predict exercise minutes post program. Likewise, self-monitoring and goal setting scores measured post program will be able to predict exercise minutes at 1-month follow-up.

Similarly to past GMCB interventions, it is hypothesized that group cohesion will increase more in the SM condition than the CON condition as many of the strategies and techniques used in GMCB interventions aim to promote group cohesion.

**Hypothesis #6:** Group cohesion will increase more in the SM condition than the CON condition from pre to post the 8-week exercise program.
The sample being tested in the current study is adults living with prediabetes or T2D. Previous interventions aimed at increasing exercise levels in adults with chronic disease have consistently demonstrated success at increasing health related quality of life (HRQL; Arthur et al., 2007; Focht, Brawley, Rejeski & Ambrosius, 2004; Hsu et al., 2011). HRQL is an individual’s subjective belief about their overall well being which takes into account their perceived physical and mental health. It is an important marker of overall health and is known to be particularly low in adults with chronic disease (Stewart et al., 1989). It is hypothesized that as both conditions must attend the 8-week exercise program, both conditions will experience increases in health related quality of life.

Hypothesis #7: Physical and mental HRQL summary scale scores will increase across time.

Some research demonstrates that exercise is associated with decreases in body mass index (BMI), waist circumference and resting heart rate, as well as increases in fitness (Carter, Banister & Blaber, 2003; Ross et al., 2000; Sternfeld, 2004). In accordance with the hypothesis that participants in the SM condition will be exercising more, it is hypothesized that they will therefore see greater improvements in these physical variables as well.

Hypothesis #8: Participants in the SM condition will have greater decreases in BMI, waist circumference, and resting heart rate than the CON condition over the course of the 8-week program. It is also hypothesized that the SM condition will have greater increases in fitness compared to the CON condition from pre to post program.

Exercise has been shown to be effective at improving BG control following an exercise training program (Boulé et al., 2001). It is therefore hypothesized that average BG levels in the SM
condition will decrease from pre to post program. BG data was not collected from participants in the CON condition.

Hypothesis #9: Average BG levels will decrease over time for participants in the SM condition.
Chapter 2: Method

2.1 Participants

Participants for this study were recruited through an exercise program called *Adults Living with Chronic Disease* (ALCD). To be eligible, interested participants had to be between 18-75 years old and diagnosed with T2D or prediabetes. Seven participants completed the CON condition (female [n = 5]) and 6 completed the SM condition (female [n = 5], $\chi^2(1) = .26, p = .61$). Four participants in the CON condition had physician-diagnosed T2D and 3 had prediabetes, as confirmed by a glycosylated hemoglobin (HbA1c) test. In the SM condition 5 participants reported being diagnosed with T2D and 1 had prediabetes. The mean age of participants was similar between conditions (CON [M = 61.14 years, SD = 8.38], SM [M = 63.50 years, SD = 4.32], $t(11) = .62, p = .55$). In both conditions participants primarily identified themselves as white (CON [n = 5], SM [n = 5]), and the remaining participants as Aboriginal. Most participants had also completed some form of post secondary education (CON [n = 5], SM [n = 4]). At the time of the study the majority of participants were not working (CON [n = 6], SM [n = 5]). Demographic characteristics can be found in Table 2.1.

2.2 Measures

All measures can be found in Appendix A.

2.2.1 Demographics

A questionnaire was used to ascertain demographic information from participants about date of birth, sex, education, occupation and ethnicity.

2.2.2 Self-monitoring, and goal setting

An exercise specific self-regulation scale was selected to measure participants’ use of self-regulation strategies (Hallam & Petosa, 2004; Petosa, 1993). Three subscales of the self-
regulation scale were used: i) self-monitoring, ii) goal setting, and iii) relapse prevention. Relapse prevention was not targeted in the intervention, however, scores from this subscale were used as a manipulation check; we would not expect the two conditions (CON and SM) to differ on the relapse prevention subscale. Responses for the 21 items included were reported on a 5-point Likert scale ranging from 1 (never) to 5 (very often). Internal consistencies for the self-monitoring, goal setting and relapse prevention subscales have been demonstrated to be acceptable in previous research (Petosa, 1993), with Cronbach’s alphas ranging from .74 to .87. In the current study Cronbach’s alpha values for the three subscales at each measurement point are as follows: i) self-monitoring (.19, .80, .81, .79, .85, .86, .85), ii) goal setting (.90, .96, .88, .94, .94, .94, .92), and iii) relapse prevention (.14, .69, .78, .68, .76, .65, .73). Apart from baseline assessments, these alpha values are congruent with the previous research in representing acceptable measures of internal consistency (Field, Miles & Field, 2012).

Additional questions were devised to assess the proportion of participants who self-monitored and the frequency that they self-monitored in the past week. Separate questions relating to BG and exercise asked participants: In the past 7 days: i) did you self-monitor your behaviour (yes, no), and ii) if yes, how many times. Response options for the number of times participants self-monitored exercise was confined to 1 through 7. For the number of times participants self-monitored BG, responses were unrestricted.

2.2.3 Self-efficacy

To measure self-efficacy to self-monitor, 5 items were developed asking participants to rate their confidence on an 11-point Likert scale with anchors from 0% (not at all confident) to 100% (extremely confident). The three items pertaining to self-monitoring of BG asked participants to rate their confidence to check, record and monitor their BG levels regularly, and
to adjust their behaviour accordingly. A sample item is: *In the next 7 days how confident are you that you can monitor your BG and adjust your behaviour accordingly?* Two items used to assess self-efficacy of self-monitoring exercise had participants rate their confidence to record and monitor their exercise bouts as well as to adjust their behaviour accordingly. A sample item is: *In the next 7 days how confident are you that you can record your exercise bouts?* Development of self-efficacy items followed recommendations put forth by Bandura (1986). Self-efficacy to self-monitor exercise and self-efficacy to self-monitor BG were scored separately, as per Bandura’s recommendations (1986). Overall self-efficacy to self-monitor exercise was calculated as mean of all self-efficacy items related to exercise and an overall self-efficacy to self-monitor BG was calculated as the mean of all self-efficacy items related to BG. Internal consistencies for self-efficacy to self-monitor exercise were considered acceptable at all time points ($\alpha = .88, .99, .97, .98$; Field et al., 2012). For self-efficacy to self-monitor BG, Cronbach’s alpha values were below what Field et al. (2012) would deem acceptable ($\alpha = no$ variability at pre, .20, .60, .53).

### 2.2.4 Exercise

Primary assessments of exercise were measured using the 7-day Physical Activity Recall Questionnaire (PAR; Sallis et al., 1985). The 7-day PAR questionnaire has been validated against physiological gold standard measures of fitness including maximal oxygen uptake test (Blair et al., 1985). There is also agreement between the questionnaire and assessment of exercise via motion sensors (Taylor et al., 1984).

In the present study, the 7-day PAR questionnaire was used to determine total exercise and independent exercise performed over the previous week. We operationalized total exercise as all moderate to very hard exercise that the participant engaged in. We operationalized independent exercise as only moderate to very hard exercise performed outside of the ALCD
exercise classes. Exercise was measured at three time points during the 8-week exercise program (pre, mid and post) and again 1-month following cessation of the program. The 7-day Physical Activity Recall Questionnaire categorizes exercise into moderate, hard or very hard intensity. In accordance with instructions from the developers of the 7-day PAR questionnaire, intensity levels were defined and specific examples of exercises were provided for each intensity category prior to participant completion of the questionnaire. Moderate intensity activities were explained as those similar to how you would feel when walking at a brisk pace. Very hard intensity activities were explained as those similar to how you would feel running, and hard intensity activities were said to be any activities between moderate and very hard. Participants were instructed to only report purposeful leisure-time exercise sustained for a minimum of 10 continuous minutes. Traditionally this questionnaire is administered in an interview format, however, for ease of allowing all members of the program to complete the questionnaire at once, the researcher explained to the whole group how to fill it out and then allowed participants to ask questions as they completed it on their own.

Total and independent exercise per week were each calculated in three ways: exercise minutes per week, frequency of exercise bouts per week and metabolic equivalents (MET) per week. MET were calculated by first converting minutes of activity per week into hours and multiplying the total number of hours spent in moderate activity by 4 MET, the total number of hours spent in hard activity by 6 MET and the total number of hours spent in very hard activity by 10 MET. The sum of these three MET calculations represented the total energy expenditure in moderate to very hard activity over a week (kcal/kg/week).
2.2.5 Attendance and re-registration for an exercise program

As a secondary assessment of exercise we recorded participant attendance at the ALCD exercise classes as well as the proportion of participants from each condition who re-signed up for a Phoenix Health and Fitness exercise program. The researcher (K.B.) logged participant attendance at the end of every exercise class. Attendance was calculated by dividing the number of classes attended by the 16 possible classes. For participants who did not enroll in the program until the second class, a percentage was calculated out of only 15 possible classes. To determine if participants re-enrolled for a Phoenix exercise program, a question was included on the final questionnaire at 1-month follow-up asking participants if they had re-registered (yes, no) and if yes, asking which program.

2.2.6 Group cohesion

A modified version of the Group Environment Questionnaire (GEQ; Carron, Widmeyer & Brawley, 1985) called the Physical Activity Group Environment Questionnaire (PAGEQ) was used to assess cohesion. Development of the PAGEQ came about when Estabrooks and Carron (2000) noticed that older adults were experiencing difficulty using the original GEQ. Preliminary evidence has demonstrated validity and reliability for the PAGEQ as a means to assess exercise group cohesion in older adults (Estabrooks & Carron, 2000). Given that participants were eligible for the current study up to the age of 75 years, the PAGEQ was deemed the most appropriate tool to use.

The PAGEQ is composed of 21-items that can be divided into 4 subscales, i) individual attractions to the group—task (IAG task); beliefs about one’s involvement with the group task, ii) individual attractions to the group—social (IAG social); beliefs about one’s relationships within the group, iii) group integration—task (GI task); beliefs about the degree of unification
within the group around its collective task, and iv) group integration—social (GI social); beliefs about the degree of unification within the group around social concerns. For each item, participants rated the degree to which they agreed on a 9-point Likert scale (1=very strongly disagree, 5=neither agree nor disagree, 9=very strongly agree). As follows are the Cronbach’s alpha values for each group cohesion subscale at pre and post intervention: IAG –task (.94, .94), IAG –soc (.96, .86), GI –task (.89, .94), and GI –soc (.68, .69). Based on recommendations by Field and colleagues (2012) all subscales had acceptable internal consistency.

2.2.7 Health related quality of life

The Short Form 36 Health Survey (SF-36; Ware & Sherbourne, 1992) is a 36-item inventory designed to assess health related quality of life (HRQL). It can be divided into 2 summary scores: i) physical component summary, and ii) mental component summary. The physical component summary score is comprised of physical functioning, role-physical, bodily pain, and general health subscales. The mental component summary score is comprised of vitality, social functioning, role-emotional, and mental health subscales. All scores are adjusted so that higher values represent better HRQL. Extensive data has been published verifying psychometric and clinical validity of this instrument (McHorney, Ware & Raczek, 1993; Ware, Kosinski & Keller, 1997). There is also a large collection of literature utilizing the SF-36 to assess HRQL in physical activity interventions (Focht et al., 2004; Rejeski et al., 2002; Schechtmen & Ory, 2001). In the current study internal consistency for physical summary scores (α = .94, .96, .94) and for mental summary scores (α = .89, .94, .93) were acceptable (Field et al., 2012).
2.2.8 Anthropometrics and heart rate

To determine body mass index (BMI), participants were asked for their height, and their weight was measured using an electronic scale (Taylor Precision Products, Oak Brook, IL) to the closest 0.1 lb. Height and weight were converted to meters and kilograms, respectively. BMI was then calculated as kg/m\(^2\). The waist circumference measurement was taken at the top of participants’ iliac crest using a standard measuring tape and following the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA) protocol (McGuire & Ross, 2008). Lastly, resting heart rate was assessed with a fingertip pulse oximeter (Medical Depot Inc., Washington, NY).

2.2.9 Fitness

To test for cardiovascular fitness participants performed the 6-min walk test (Enright, 2003). This test is a measure of the maximum distance walked in 6 minutes. The 6-min walk test is a validated test often used in samples of elderly adults with multiple co morbidities (Beriault et al., 2009; Enright et al., 2003; Harada, Chiu & Stewart, 1999; Peeters & Mets, 1996; Rikli & Jones, 1998).

2.2.10 Blood glucose

The SM condition wore continuous glucose monitors (CGM) for five consecutive three times throughout the 8-week intervention (pre, mid, post). More detail regarding the CGM devices can be found later in the methods section within the SM intervention section.

BG data were downloaded from the CGM monitor through Medtronic’s online system (https://carelink.minimed.com). From the raw BG data estimates of mean BG and mean amplitude of glycemic excursion (MAGE) were calculated. A review of the dangers due to impaired BG illustrates that although it is well documented that sustained high BG leads to many
of the complications associated with diabetes, a growing body of literature demonstrates that acute fluctuations in BG (i.e., ‘spikes’ and ‘dips’) may also independently impose a danger (Monnier & Colette, 2008). Therefore in the present study in addition to mean BG, MAGE was calculated to assess the degree of acute fluctuations in BG.

2.3 Procedures

Ethical approval for this study was obtained through the University of British Columbia’s Clinical Research Ethics board (H13-00648).

2.3.1 Recruitment

Participants for the study were recruited by the researcher (K. B.) during the initial week of an exercise program run by Phoenix Health and Fitness in Kelowna, British Columbia. The program, Active Living with Chronic Disease (ALCD), is designed for individuals who are inactive and are living with a chronic disease. It is 8-weeks long and consists of two 90-minute classes per week comprised of 45-minutes of exercise and 45-minutes of informational discussion on relevant health topics led by a health care professional or a trained staff member. Phoenix Health and Fitness describe the purpose of the program as ‘providing the information and tools necessary for participants to manage their own condition’ (http://phoenixfitnesskelowna.ca/healthyteeth/8/active_living_with_chronic_disease.php). Recruitment for the exercise program is primarily performed in conjunction with general physicians from the community who refer patients that have been diagnosed with a chronic disease and are primarily sedentary. Additionally, some participants hear about the program through others in the community. Interested individuals coming from the community without referral have to be medically cleared prior to participation in the ALCD program.
2.3.2 Study design

The current study collected data from two sessions of the ALCD classes: Spring (April 23- June 13) and Fall (September 17- November 7). It was a quasi-experimental design, whereby separate sessions were assigned to be the standard care condition (CON) and the self-monitoring intervention condition (SM). Due to logistical reasons regarding shipment of CGM equipment, the Spring session was assigned to CON and the Fall session was assigned to SM. Historically, climate in Kelowna is similar between the Spring and Fall so temperature was not anticipated to differ between exercise program sessions.

2.3.3 Eligibility

Participants in both conditions were informed about the study by the researcher and offered a chance to become involved during the initial exercise class. Individuals expressing interest in the study were screened for study eligibility onsite. Inclusion criteria required participants to be enrolled in the ALCD group, be between the ages of 18 and 75 years, be diagnosed with T2D or prediabetes, have the ability to read and write English at a grade 6 level or higher and score at least 24 on the Mini Mental State Examination.

Participants were asked whether they had previously been diagnosed with T2D or prediabetes. Those who had not been diagnosed, or were unsure of their diabetic status were administered an HbA1c test (A1CNow self-check system, Bayer Inc.: Toronto, ON). There is a large proportion of the Canadian population believed to be living with undiagnosed diabetes or prediabetes, and therefore, this test allows assessment of diabetic risk onsite, even if individuals believe they are not at risk (Canadian Diabetes Association, 2012). The test is comprised of drawing a small droplet of blood from the finger in order to measure HbA1c (an estimate of average BG over the past 2-3 months). Participants with an HbA1c value of 6.5% or higher were
considered T2D, with a value of 5.7% to 6.4% they were considered prediabetic, and with a value lower than 5.7% they were considered to have healthy BG levels, as per the American Diabetes Association’s guidelines (American Diabetes Association, 2012). Participants without T2D or prediabetes were still permitted to participate in the study as a means of facilitating group cohesion, however, their data was not included for analytic purposes (CON [n=0], SM [n=2]). Additional screening included asking interested participants their age, and administering the Mini Mental State Examination (Appendix B; Folstein, Folstein & McHugh, 1975). The last criterion was included because many components of the study, particularly operating the continuous glucose monitors (CGM) that participants wore, required the ability to follow complex instructions.

Eligible participants were provided a Letter of Informed Consent (Appendix C), and the researcher or a trained research assistant explained each section of the form to them, allowing ample opportunity to answer questions and concerns. By signing the Letter of Informed Consent participants indicated that they wished to volunteer to be a part of the study. However, when providing consent, it was made clear to participants that they could withdraw from the study at any point in time with no detrimental consequences should they no longer wish to be involved.

2.3.4 Active Living with Chronic Disease classes

Participants in both groups (CON, SM) attended the program two times per week for 8-weeks, for a total of 16 classes. These classes lasted approximately 90 minutes. The first 45-minutes consisted of a guided exercise session and the last 45-minutes consisted of an educational tutorial. In both sessions the researcher led 6 of the tutorials, ensuring equal researcher contact time between the two groups. A summary of topics discussed during the researcher led tutorials can be found in Appendix D. ALCD staff or health care professionals led
all other tutorials not led by the researcher and similar content was covered between conditions. A comprehensive list of topics discussed within each condition can be found in Appendix E.

During the first class participants did not partake in any exercise. Introductions were made and each participant was given an opportunity to tell the group why he or she joined the program. The director of the facility explained what participants should expect over the next 8-weeks and how they should prepare (i.e., what to wear). Baseline anthropometric measurements (height, weight, and waist circumference) and resting heart rate were collected from all participants during the initial class. These measurements were taken again twice throughout the program, mid-way (Class #7) and near the end (Class #14). During the second class, participants underwent fitness testing via the 6-min walk test. This testing occurred again during the last week of the program (Class #15).

For all other classes, participants engaged in 45-minutes of exercise divided into approximately 30-minutes of aerobic activity, 10-minutes of strengthening exercises and 5-minutes of stretching. The aerobic exercise portion included a variety of activities including marching, heel-tapping, stepping and walking through a ladder, all of which increased in speed and difficulty with progression of the classes. During later weeks in the program some participants were provided with the opportunity to try out cardiovascular exercise equipment including a treadmill, elliptical and stationary bicycle. Strength exercises were usually performed with weights or bands and generally aimed to increase strength in both upper extremities (i.e., biceps, triceps) and the lower extremities (i.e., hamstrings, gluteus maximus). Additionally, throughout the entire class there was always a focus on proper posture and engaging one’s core muscles. It is important to note that despite this being the basic structure of all classes, there was a lot of variability between what individual participants did due to physical limitations. The same
instructors, who were certified through the Canadian Society for Exercise Physiology, led all of the exercise classes. Trainers were aware of each participant’s physical limitations and were able to offer modifications to all exercises. In addition to these certified trainers, Human Kinetics undergraduate students volunteering from the University of British Columbia Okanagan assisted in running the classes by leading participants through exercise stations and ensuring participants were using correct exercise form.

2.3.5 Measurement time points

Questionnaires were always administered following the educational component of the class. Baseline assessments were divided between Class #1 and Class #2 and post-program assessments were divided between Class #15 and Class #16 as a means of minimizing participant burden. A pictorial overview of when measures were assessed can be found in Appendix F.

All demographical measurements were gathered at baseline (Class #1). Self-monitoring and goal setting were assessed at seven time points. The first six measurement time points coincided to before and after participants in the SM group were asked to monitor their BG levels (Classes #2, 4, 8, 10, 14, 16) and the last measurement was at week 12 (1-month follow-up). Self-efficacy was assessed at baseline (Class #1), mid-way through the program (Class #10), directly post-program (Class #16) and at week 12 (1-month follow-up). Exercise assessments via the 7-day PAR were measured at baseline (Class #2), mid-way through the program (Class #10), directly post-program (Class #16), and at week 12 (1-month follow-up). HRQL was assessed at baseline (Class #1), directly post-program, (Class #16) and week 12 (1-month follow-up). Group cohesion was assessed at baseline (Class #2) and in the last week of the program (Class #15).

A qualitative interview was administered to each participant by phone the week following the end of the program (Appendix G). Participants were asked questions related to logistics and
fidelity of the intervention, and, in the SM group, questions about the usability of wearing a CGM. One-month following the last class (week 12) participants completed a final survey. They were asked during the final exercise class if they would prefer to receive it by post or hand delivered to their house by the researcher. They were instructed to complete and return this survey to the researcher and if they had not returned it they were reminded to do so once by means of a telephone call.

2.3.6 Unique components of the standard care and self-monitoring conditions

2.3.6.1 Standard care condition (CON).

2.3.6.1.1 Tutorials. Throughout the CON session, the researcher led six of the educational tutorials following the exercise portion of the classes and discussed an assortment of general health topics including: i) the impact of stress on health (Class #2), ii) abdominal adiposity (Class #4), iii) dietary fiber (Class #8), iv) the importance of sleep (Class #10), v) mental health (Class #14), and vi) flu vaccinations (Class #16). Scripts used for these tutorials can be found in Appendix H.

2.3.6.1.2 Remuneration. Participants in the CON group received a total of $50 in remuneration for their time. They received $25 on the last class of the 8-week program after completing all questionnaires, and the final $25 once they had returned their final questionnaire during week 12 (1-month follow-up).

2.3.6.2 Self-monitoring intervention condition (SM). The SM group received an intervention modeled from a group mediated cognitive behavioural approach (GMCB; Brawley et al., 2000; Cramp & Brawley, 2006, 2009; Rejeski et al., 2003), which aims to teach self-regulatory skills utilizing a group setting to foster greater commitment and understanding of self-
regulation from participants. A novel component of this intervention was the use of continuous glucose monitors (CGM).

2.3.6.2.1 Continuous glucose monitors (CGM). CGM are devices that allow one to continuously measure and observe their own BG levels throughout the day. CGM estimate average BG every 5-minutes based on a reading of the interstitial fluid in the abdominal adipose tissue. Participants wore these devices at three time points throughout the 8-week program, week 1, week 4 and week 7, each time for five days. To allow participants to self-monitor their BG ‘real-time’ CGM were utilized and BG values were not blinded to the participant (Guardian REAL-time Continuous Glucose Monitoring System, Medtronic: Northridge, CA). Each CGM included a monitor that was worn like a pager or kept in a pocket. This electronic monitor provided the wearer with a constant reading of what their current estimated BG was, as well as a visual graph of their estimated real-time BG over the past 24-hours in 5-minute data point sampling collections (please see Appendix I for a photo of a CGM). The devices require a calibration from the wearer every 12 hours using a fingertip capillary BG reading. Therefore participants were also supplied with a glucose meter (OneTouch UltraMini, LifeScan Canada, Burnaby, BC), or if they preferred, they used their own glucose meter.

2.3.6.2.2 Educational tutorials. Scripts for all tutorials can be found in Appendix H and a timeline summarizing topics discussed during tutorials can be found in Appendix D. The first tutorial led by the researcher occurred directly before the first time participants received their CGM (Class #2). Topics covered in this tutorial included i) what happens inside your body when you have T2D and prediabetes, ii) BG: what it is and why it is important, and iii) instructions regarding how to use a CGM (i.e., when and how to calibrate the device). Participants also
received a logbook (Appendix J) and were instructed to write down their BG four times a day and to write down everything they ate/drank for the five days that they wore the CGM.

The second tutorial led by the researcher took place the class after the CGM had been removed (Class #4). It involved a discussion about i) participants’ experiences wearing the CGM and self-monitoring, ii) the connection between an acute exercise bout and improved control of BG levels, iii) self-monitoring: what it is and why it is important. These types of group discussions are used in GMCB interventions not only as a means of teaching self-regulatory skills but also to foster a more cohesive environment. To emphasize the relationship between exercise and BG control, each participant was also supplied with a graph of his or her BG and their attention was directed towards instances where exercise improved their BG control.

The third tutorial occurred directly following the second tutorial (Class #5). This tutorial covered i) Canada’s physical activity guidelines, ii) exercise goals and iii) self-monitoring of exercise. Participants were asked to make an individual exercise goal following the “SMART” principle (Specific, Measurable, Attainable, Realistic, Time-frame). The importance of self-monitoring was re-enforced and participants were asked to self-monitor their exercise for the next 9-days on a calendar provided in their logbook. This included recording the type of activity, the duration (minutes), their Rating of Perceived Exertion, and any additional thoughts/feelings. As well, participants collectively decided on a group goal. When participants successfully achieved their group exercise goal the researcher provided all participants with a small reward. The group goal and reward were methods used to further promote group cohesion.

The fourth tutorial led by the researcher occurred directly prior to the second time that participants received a CGM (Class #8). During this tutorial there was a discussion about i) participants’ experience self-monitoring their exercise, and ii) a reminder about the relationship
between exercise and improved BG control. Participants were given an opportunity to make a new individual exercise goal. Participants were asked to record, for the next 5-days, BG, diet and exercise in their logbooks. Additionally, participants were asked to try an “experiment”: to eat the same food 2-days in a row, but on the first day not to exercise, and on the second day to exercise. This was done so that participants could see the effects of exercise on BG in their own bodies.

The fifth tutorial led by the researcher occurred the class after the second CGM was removed (Class #10). This tutorial focused on i) looking at participants’ own BG graphs and ii) learning about action plans. Participants received a printout of their BG levels from the past 5-days. They were given an opportunity to ask any questions and to discuss their graphs with each other in an effort to interpret what they meant, while the researcher pointed out evidence showing how exercise helped BG control for each participant. The remainder of the tutorial focused on teaching participants a new skill, how to make action plans. This required them to each write down on a calendar exactly what, where and when they were planning to exercise for the week. They were told to create an action plan that was congruent with their exercise goal, such that if their goal was to exercise 150-minutes a week, their action plan should include at least 150-minutes of activity. For the next 2-weeks participants were asked to continue self-monitoring their exercise on a page provided in their logbook. Prior to the third CGM insertion the researcher did not lead a tutorial, however, participants were reminded of what they needed to do when wearing the CGM.

The sixth and final tutorial was on the last class (Class #16) and it was the class following the removal of the third CGM. During this session participants received a graph of their BG levels from the final time that they wore their CGM and they were able to compare their BG
control with the previous two times that they had worn the monitor. Participants were provided with a new logbook (Appendix K) for the next month where they could keep track of their exercise goals, action plans and self-monitoring of exercise upon leaving the ALCD program. Participants were asked to set new goals and action plans for the next month and the researcher provided feedback for each participant.

During the classes that the researcher did not lead a tutorial, the researcher continued to check participants’ logbooks and provide feedback on participants’ exercise goals, self-monitoring activities and action plans. At this time the researcher would try to help participants who were having trouble with these skills. The researcher would also sum all participants’ exercise minutes and update progress towards the group goal. Scripts followed during these check-in times can be found in Appendix H, organized by exercise class number.

Typically GMCB structured interventions include a transition period where there is a decreased reliance on the exercise group setting and participants are taught how to exercise independently. This is often facilitated by decreasing the number of group exercise classes per week and in response having participants increase the number of exercise sessions they do on their own, while still keeping in close contact with the researcher. In the present study there was not a transition period due to constraints from the ALCD program as we were not able to slowly decrease the number of group exercise sessions held.

2.3.6.2.3 Remuneration. Participants in the SM group received $100 in remuneration for their time. They received $75 on the last class of the 8-week program ($50 for wearing the CGM three times and $25 for completing all questionnaires). They received the final $25 once they had returned their completed final questionnaire during week 12 (1-month following the end of the program).
Chapter 3: Results

3.1 Participant Flow

Seventeen participants expressed interest in the study (CON [n=7], SM [n=10]). Of these, two participants in the SM condition did not meet the inclusion requirement for impaired BG (HbA1c value ≥ 5.7%). These two individuals were still invited to be involved in the group discussions and were able to complete study questionnaires if they desired, but their data was excluded from analyses. An eligible participant from the SM condition completed the first set of baseline questionnaires and then chose not to participate due to disinterest in the exercise classes (of note: this participant wanted to continue on in the study but was not permitted to do so because he failed to attend the exercise classes). As such, fourteen eligible participants started the 8-week program. One additional participant in the SM condition withdrew after being relocated for work. Thirteen participants (CON [n = 7], SM [n = 6]) completed the 8-week program and responded to follow-up data 1-month post program. For an illustration of participant flow please see Figure 3.1.

3.2 Analytic Plan

Data was analyzed using SPSS Statistics (Version 22). Preliminary analyses involved scanning data for missing values and identifying univariate and multivariate outliers. Next, data were tested for assumptions associated with the pertinent statistical tests. To examine equivalency between conditions for participant demographics and study variables at baseline, chi square tests, t-tests, and multivariate analyses of variance (MANOVA) were conducted as appropriate.

All effects for main analyses are reported as significant at $p < .05$. However, in light of the small sample size and exploratory nature of this feasibility study, we chose to allow for
further analysis of all effects at the $p \leq .10$ level, in conjunction with a heavier reliance on interpretation of effect sizes rather than significance levels. Effect sizes calculated included partial eta squared, Cohen’s $d$, odds ratios and phi, as appropriate. Effect sizes should be interpreted within the context of the research field, therefore effect sizes were interpreted using standards appropriate for behavioural psychology research as follows. Partial eta squared was interpreted as small (.01), medium (.06) and large (.14) and Cohen’s $d$ as small (.20), medium (.50), and large (.80; Cohen, 1988). Odds ratios of 2.0 were interpreted to be small, 3.0 medium and 4.0 large (Ferguson, 2009). Lastly, when using phi (Φ) suggested interpretation guidelines for the effect size small (0.20), medium (0.50), and large (0.80) were used (Hojat & Xu, 2004).

To test the study hypotheses regarding whether differences existed between conditions and over time, primarily MANOVA, analyses of variance (ANOVA) and t-tests were conducted. For variables with significant baseline differences between conditions, analyses of covariance (ANCOVA) were used to control for baseline values. Regression analyses were performed to test for predictors of exercise behaviour. Lastly, to examine hypotheses assessing the association between condition and a dichotomous outcome, chi square analyses were carried out. Interviews for qualitative analyses were recorded by audiotape and transcribed verbatim. All questions and corresponding responses from the qualitative interviews were included in the analyses. Themes emerging from the responses were identified by K. B. and confirmed by M. J.

3.3 Preliminary Analyses

3.3.1 Missing data

Missing data for psychological variables (self-regulation subscales, frequency of self-monitoring, self-efficacy, group cohesion and HRQL) were replaced using the within-person mean of the composite score. This was only done if at least 50% of the items in the composite
score were available (Tabachnick & Fidell, 2007). Five missing values were found, and all occurrences were within group cohesion items. If a participant failed to complete an entire measure the participant was excluded from any analyses that included the missing measure. Participants were given one extra class to make-up for missed questionnaires, such that if a participant was absent during a class when a questionnaire was administered they were asked to complete it the following class. Two participants had incomplete data due to missing psychological variables. One participant in the CON condition was absent during Class #13 and absent for the make-up class (Class #14), and therefore did not complete the self-regulation questionnaire and self-monitoring frequency questions for week 7. One participant in the SM condition joined the program during the second class and did not feel comfortable completing the pre assessment of group cohesion due to not yet experiencing the class atmosphere.

For BMI, waist circumference, heart rate, 6-min walk test, 7-day Physical Activity Recall (PAR) questionnaire, and BG measurements, if a participant missed an assessment then they were excluded from all analyses for that variable. This occurred once: A participant in the SM condition did not have BMI or waist circumference assessed at mid-program because he was late to class. All PAR questionnaires were complete. BG assessments (mean BG, MAGE) were only calculated for the SM condition because the CON condition did not wear CGM. One participant from the SM condition was excluded from BG analyses due to technical difficulties using the CGM and therefore this participant had incomplete data for all associated CGM variables.

3.3.2 Outliers

Fidell and Tabachnick (2003) suggest that a z-value of ±2.58 be used as the cut-off for outliers in studies with small sample sizes. Therefore, with the exception of 7-day PAR derived exercise minutes, outliers were identified with these guidelines. Exercise minutes were not
considered outliers if the z-value was lower than –2.58, as it is not uncommon for an adult with a chronic disease to perform as little as zero minutes of moderate to vigorous exercise lasting consecutively for at least 10-minutes.

Following these guidelines, seventeen univariate outliers were found within the following variables: self-regulation subscales, self-monitoring frequency, self-efficacy, group cohesion, and HRQL. The offending cases were assigned a value one unit smaller or larger than the next most extreme value (Tabachnick & Fidell, 2007). No outliers were found in anthropometrics, resting heart rate, 6-min walk test or BG assessments.

Three participants (CON [n=2], SM [n=1]) were considered outliers for total and independent 7-day PAR derived exercise minutes and therefore they were excluded for all 7-day PAR related analyses. Following suggestions by Tabachnick and Fidell (2007), exclusion was selected as the course of action to handle these outliers because the amount of exercise they were reporting (974 min/week and 780 min/week for participants in CON condition, 1020 min/week for participant in SM condition) would be highly unusual for the target population (primarily sedentary adults with chronic disease) and therefore they were not considered inclusive of the target population. Another participant in the CON condition was excluded from total and independent exercise analyses because he reported that he inaccurately completed the 7-day PAR questionnaires.

Multivariate outliers were defined as any combination of variables with a mahalanobis distance that had a corresponding significant $\chi^2$ value ($p < .001$; Tabachnick & Fidell, 2007). Multivariate outliers were tested for in all variables included in multivariate statistics (self-regulation subscales; frequency to self-monitor; and anthropometrics and heart rate) by examining mahalanobis distances. No multivariate outliers were identified.
3.3.3 Checking assumptions of statistical procedures

Prior to all main analyses, data were tested for violations of the statistical procedures utilized. This includes the following procedures and their corresponding assumptions: i) repeated measures MANOVA: assumptions of normality, independence, sphericity, interval level data, and homogeneity of variance-covariance matrices; ii) repeated measures ANOVA: assumptions of normality, independence, sphericity, interval level data, and homogeneity of variance matrices; iii) linear regression: assumptions of normally distributed errors, independence, homoscedasticity, interval level data, non-zero variance, predictors uncorrelated with external variables, and linearity; iv) independent samples t-test: assumptions of normality, independence, and interval level data; and v) chi-square test: assumptions of independence and that the expected cell count is higher than zero (Field et al., 2012). Violations of assumptions are detailed below.

3.3.3.1 Normality. Statistics of kurtosis and skewness were used to assess normality of variables, along with visual inspection of histograms. Minutes of exercise, frequency of exercise bouts and METS were positively skewed. However, this data was not normalized because it is characteristic of this population (adults with chronic disease) to have low exercise levels and thus the data was believed to accurately represent true exercise levels.

3.3.3.2 Sphericity. Mauchley’s test indicated that the assumption of sphericity had been violated for the main effects of 4 variables: frequency of self-monitoring exercise, frequency of self-monitoring BG, BMI and heart rate. Therefore, for these variables degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity.

3.3.3.3 Homogeneity of variance. The homogeneity of variance assumption was violated for total and independent frequency of exercise bouts, and self-efficacy to self-monitor BG.
However, when sample size is equal between conditions ANOVA is considered robust to violations of the assumption of homogeneity of variance (Field et al., 2012). This was the case for both frequency of exercise bouts and self-efficacy to self-monitor BG.

Homogeneity was also violated in the following variables for which there were not equal sample sizes for groups: frequency of self-monitoring exercise, frequency of self-monitoring BG, AIG –task (group cohesion subscale) and the sit to stand test. Although sample sizes were not equal, when the group with the larger sample size produces greater variance then probability values are considered conservative, as was the case with these violations (Tabachnick & Fidell, 2007).

Lastly, homogeneity of variance was also violated for body mass index (BMI), in which there was not equal sample sizes between conditions and there was greater variance in the condition with a smaller sample size. This could not be statistically adjusted for and analyses were run regardless. This violation should be considered when interpreting results.

3.3.3.4 Predictors uncorrelated with external variables. Predictors were highly correlated with external variables for two regression models thus violating an assumption for linear regression. This occurred for the self-monitoring scale at week 7 only, which was highly correlated with frequency to self-monitor exercise at week 7 only; and the self-monitoring scale at week 8 only, which was highly correlated with frequency to self-monitor exercise at week 8 only. Violation of this assumption is problematic because conclusions drawn from the resulting model are unreliable given that another variable is equally effective at predicting the outcome (Field et al., 2012). However, in this case, as the predictor and external variables are both measures assessing self-monitoring of exercise conclusions drawn from the models will not be affected by these violations. Furthermore, it is theoretically hypothesized that measures of how
well participants were self-monitoring (self-monitoring scale) would be significantly correlated to the frequency in which they self-monitored.

3.3.4 Baseline equivalency

To assess if differences between conditions existed for age and gender, an independent samples t-test and chi square analysis were conducted. No significant differences were found. In order to examine if differences between conditions existed at baseline for total exercise (minutes, frequency of bouts and MET), independent exercise (minutes, frequency of bouts and MET), self-regulation subscales (self-monitoring, goal setting, relapse prevention), frequency of self-monitoring (frequency to self-monitor exercise and BG), group cohesion (IAG –task, IAG –soc, GI –task, and GI –soc), HRQL (physical summary scale and mental summary scale), and resting heart rate and anthropometrics (resting heart rate, BMI, waist circumference), separate MANOVA were performed. The SM condition had significantly higher scores for group cohesion subscales GI –task, and GI –soc at baseline in comparison to the CON condition. As a result, baseline scores were controlled for in group cohesion analyses. A chi-square test was used to examine if there were differences between conditions in the proportion of participants who self-monitored their exercise and the proportion of participants who self-monitored their BG at baseline. Analyses revealed that at baseline a significantly higher proportion of people in the SM condition monitored their BG then in the CON condition. Knowledge of this baseline difference was considered when results from later time points were interpreted. Lastly, to examine if there were differences between conditions in self-efficacy to self-monitor exercise, self-efficacy to self-monitor BG and the 6-min walk test, independent samples t-tests were performed. The SM condition had significantly lower baseline scores in the 6-min walk test compared to the CON
condition, and therefore baseline values were controlled for in subsequent fitness analyses. Descriptive baseline statistics for all study variables can be found in Table 3.1.

3.3.5 Intervention fidelity

To provide data on intervention fidelity, logbooks were analyzed for completeness by calculating the percentage of BG and diet entries accurately completed, the percentage of exercise goals and action plans created, the number of exercise bouts recorded and the percentage of weekly exercise minutes tallied. While this is considerably more in-depth than the intervention fidelity check conducted in the only other CGM-related exercise adherence feasibility study (Allen et al., 2009), we believe it is critical to assess fidelity prior to making judgments on intervention efficacy.

In accordance with instructions provided to SM participants only, a complete BG log consisted of four BG entries per day while the CGM was worn. A complete diet log was operationalized as at least three separate diet entries recorded per day for all days the CGM was worn. It was assumed that the majority of people consume at least three separate meals each day and, therefore, recording less than three diet entries indicates a failure at self-monitoring. These guidelines for assessing food diary completeness have been used previously (Baker & Kirschenbaum, 1993). Participants had high compliance recording BG levels ($M = 90.43\%$ complete, $SD = 12.14\%$) and diet ($M = 94.81\%$ complete, $SD = 8.74\%$).

SM participants were required to create new exercise goals weekly and an exercise goal was considered complete if it specified a measurement of volume (e.g., minutes of exercise, number of exercise classes). Participants had acceptable success completing exercise goals during the intervention ($M = 75.00\%$ complete, $SD = 22.36\%$), however, percentage of goals filled-out during 1-month follow-up was poor ($M = 37.50\%, SD = 37.91\%$).
SM participants were introduced to action plans mid-way through the intervention and were asked to complete action plans in their logbooks for the final three weeks of the intervention. During 1-month follow-up participants were asked to create action plans for all four weeks. A complete action plan was operationalized as any entry that specified a measurement of time (e.g., 9:00AM, morning) and activity (e.g., walk, aerobic class). During the intervention participants completed a mean of 13.33 ($SD = 5.16$) action plans and during 1-month follow-up participants recorded a mean of 13.50 ($SD = 10.84$) action plans.

SM participants were also asked to self-monitor their daily exercise. An entry was considered complete if it included an activity (e.g., walking, Phoenix class) and duration (e.g., minutes). Participants recorded a mean of 36.50 ($SD = 24.16$) exercise bouts during the intervention, and 19.50 ($SD = 17.51$) exercise bouts during 1-month follow-up.

Lastly, at the end of each week SM participants were instructed to tally their exercise minutes. During both the intervention and during 1-month follow-up participants were poor at tallying their exercise minutes. On average, participants tallied their weekly exercise minutes 60.00% ($SD = 28.28$%) during the intervention, and 50.00% ($SD = 41.83$%) during follow-up.

3.4 Main Analyses

3.4.1 Self-monitoring and goal setting

3.4.1.1 Hypothesis #1: Self-monitoring and goal setting subscales and frequency of self-monitoring. To examine the first hypothesis regarding differences in self-monitoring and goal setting between conditions, a 2 (condition: CON, SM) x 6 (time: week 2, week 4, week 5, week 7, post, follow-up) repeated measures MANOVA was performed for the outcome variables self-monitoring, goal setting and relapse prevention. Baseline scores were excluded from analyses due to low Cronbach’s alpha scores in the self-monitoring subscale ($\alpha = .19$) and the
relapse prevention subscale ($\alpha = .14$). However, as we did not intervene to change self-monitoring or goal setting behaviour until following the second week, scores from week 2 can be used as a suitable baseline. The overall multivariate effect for time was significant, $F(15, 150) = 2.27, p < .01$. The effects for condition, $F(3, 8) = 2.56, p = .13$, and the Condition x Time interaction, $F(15, 150) = 1.63, p = .07$, were not significant. As the main effect for time, and the interaction were associated with $p$ values $\leq .10$, further exploration was warranted. Follow-up univariate analyses revealed that the interaction effect for Condition x Time was significant in the self-monitoring composite score, $F(5, 50) = 4.63, p < .01$, partial $\eta^2 = .32$, as well as for the goal setting composite score, $F(5, 50) = 3.29, p = .01$, partial $\eta^2 = .25$. These effect sizes signify large effects. This indicates that self-monitoring and goal setting changed differently over time depending on which condition participants were in. To better interpret these differences post hoc t-tests were conducted between conditions at all time points. Alphas were not corrected for the multiple analyses performed due to the small sample size and exploratory nature of this feasibility study. These tests suggest higher self-monitoring composite scores in the SM condition at week 4 ($p = .06$), week 5 ($p < .01$) and 1-month follow-up ($p < .01$) and higher goal setting composite scores in the SM condition at week 5 ($p = .06$). As a manipulation check, the relapse prevention composite score within this self-monitoring measure was also compared between conditions. There was a near significant main effect for time for relapse prevention, $F(5, 50) = 2.35, p = .05$, partial $\eta^2 = .19$, such that week 4 ($p = .02$), week 7 ($p = .046$), week 8 ($p = .07$), and week 12 ($p = .03$) were all higher than baseline scores. As anticipated, there was no Condition x Time interaction for the relapse prevention subscale, $F(5, 50) = 0.47, p = .80$, partial $\eta^2 = .05$. Please see Figure 3.2, Figure 3.3, and Figure 3.4 for graphical representations of changes in the self-regulation subscales.
Chi-square tests were performed post program and at 1-month follow-up to examine the association between study condition and whether participants self-monitor. Chi-square analyses examining the proportion of participants who self-monitored exercise revealed differences between conditions at the $p \leq .10$ level post program, $\chi^2(1) = 3.34, p = .07, \Phi = .51$, and at 1-month follow-up, $\chi^2(1) = 6.20, p = .01, \Phi = .69$, with a higher proportion of participants self-monitoring in the SM condition. These effect sizes are indicative of medium to large effects.

Chi-square analyses to assess the association between condition and self-monitoring of BG uncovered a significant relationship post program, $\chi^2(1) = 4.95, p = .03, \Phi = .62$, with a higher proportion of participants in the SM condition self-monitoring, but not at 1-month follow-up, $\chi^2(1) = 0.74, p = .39, \Phi = .24$. The effect size post program is considered a medium sized effect and the effect size at 1-month follow-up is considered a small effect. However, interpretation of significant results regarding the proportion of participants who self-monitor BG must take into consideration that there were group differences at baseline.

To examine if differences existed between conditions in the frequency that participants self-monitored, a 2 (condition: CON, SM) x 7 (time: pre, week 2, week 4, week 5, week 7, post, follow-up) repeated measures MANOVA was performed for the outcome variables frequency of self-monitoring exercise and BG. The overall multivariate effect for time was significant, $F(12, 120) = 4.55, p < .01$, but the effect for condition was not significant, $F(2, 9) = 2.19, p = .17$. The overall effect for the Condition x Time interaction was significant, $F(12, 120) = 3.48, p < .01$. Univariate follow-up analyses revealed interaction effects for frequency of self-monitoring exercise, $F(1.97, 19.68) = 4.07, p = .03$, partial $\eta^2 = .29$, but not for frequency of self-monitoring BG, $F(2.01, 20.05) = 3.29, p = .06$, partial $\eta^2 = .25$. These effect sizes are interpreted as being a large effect. Post hoc analyses were conducted for exercise self-monitoring frequency, and also
for BG self-monitoring frequency, as the effect for the interaction for frequency of self-monitoring BG was associated with a $p$ value $\leq .10$. These post hoc tests assessed whether there were differences between conditions in the frequency participants self-monitored by conducting independent sample t-tests for each time point. Again, alphas were not corrected for due to the limited sample size. Tests revealed a tendency for greater frequency of self-monitoring exercise in the SM condition at week 4 ($p < .01$), week 5 ($p = .06$), week 7 ($p = .05$) and week 8 ($p = .09$). There were no significant differences between conditions for frequency of self-monitoring BG. Please see Figure 3.5, and Figure 3.6 for visual depictions of the changes in frequency of self-monitoring exercise and BG, respectively.

3.4.1.2 Hypothesis #2: Self-efficacy to self-monitor. A secondary hypothesis related to self-monitoring was that participants’ self-efficacy to self-monitor would increase more in the SM condition than CON. A series of two, 2 (condition: CON, SM) x 4 (time: pre, mid, post, follow-up) repeated measures ANOVA were performed for the outcomes self-efficacy to self-monitor exercise and self-efficacy to self-monitor BG. Cronbach’s alpha scores for the self-efficacy to self-monitor BG were low ($\alpha = no$ variability at pre, .20, .60, .53). Participants with T2D could have had confidence recording their BG values but no confidence to change their behaviour, particularly at the start of the program. Therefore these values are not surprising and analyses were run in spite of the low Cronbach’s alpha scores.

In self-efficacy to self-monitor exercise, the effect for time was not significant, $F(3, 27) = 1.29, p = .30$, partial $\eta^2 = .13$, nor was the effect for condition, $F(1, 9) = 1.50, p = .25$, partial $\eta^2 = .14$. However, the interaction effect between condition and time was significant, $F(3, 27) = 4.42, p = .01$, partial $\eta^2 = .33$. Effect sizes for all effects range from medium to large, however, the Condition x Time interaction had a considerably larger effect than condition or time for self-
efficacy to self-monitor exercise. Post hoc independent sample t-tests revealed that the SM condition had significantly greater self-efficacy to self-monitor exercise at mid program \((p = .048)\) and at 1-month follow-up \((p = .04)\). In self-efficacy to self-monitor BG the effects for time, \(F(3, 12) = 2.19, p = .14\), partial \(\eta^2 = .35\), and condition, \(F(1, 4) = 1.83, p = .25\), partial \(\eta^2 = .31\), were not significant. The interaction effect for Condition x Time was also non-significant, \(F(3, 12) = 1.55, p = .25\), partial \(\eta^2 = .28\). Despite non-significant effects, the effect sizes are all interpreted as large effects. Please see Figure 3.7, and Figure 3.8 for graphs depicting changes in the self-efficacy.

### 3.4.2 Exercise

**3.4.2.1 Hypothesis #3: Total and independent exercise.** Regarding the primary exercise hypotheses, 2 (condition: CON, SM) x 2 (time) repeated measures ANOVAs were conducted to assess if differences existed between conditions for minutes of exercise, frequency of exercise bouts, and MET. Separate ANOVAs were conducted for each minutes, frequency and MET because these variables are derived from the same raw data (7-day PAR) and therefore should not be entered into a single MANOVA. Analyses were performed for pre to post and for pre to follow-up. These analyses were run separately for total exercise and independent exercise.

Cohen’s \(d\) was calculated for the Time x Condition interactions using the difference score from pre to post or pre to follow-up, accordingly. Due to the small study sample size and large standard deviations common in exercise, a heavy reliance was placed on the interpretation of effect sizes for the interactions. No significant effects were found for time, condition or for the interactions between time and condition. Results from the analyses are detailed below. Graphs detailing changes in total exercise can be found in Figure 3.9, Figure 3.10, and Figure 3.11.
Graphs detailing changes in independent exercise can be found in Figure 3.12, Figure 3.13, and Figure 3.14.

3.4.2.1.1 Total exercise. In total exercise, the effect for time from pre to post was not significant for minutes of exercise, $F(1, 7) = 0.46, p = .52$, frequency of exercise bouts, $F(1, 7) = 0.15, p = .71$, or MET, $F(1, 7) = 1.35, p = .28$. Similarly, the effect for condition was not significant for minutes of exercise, $F(1, 7) = 0.26, p = .63$, frequency of exercise bouts, $F(1, 7) = 0.50, p = .50$, or MET, $F(1, 7) = 0.19, p = .67$. Lastly, the effect for Condition x Time was not significant for minutes of exercise, $F(1, 7) = 0.42, p = .54$, $d = 0.41$, frequency of exercise bouts, $F(1, 7) = 0.36, p = .57$, $d = 0.39$, or MET, $F(1, 7) = 0.55, p = .48$, $d = 0.47$. However, as can be seen by the effect sizes, minutes of exercise, frequency of exercise bouts and MET have small to medium sized effects with a greater increase in exercise levels observed in the SM condition compared to the CON condition.

In total exercise from pre to follow-up the effect for time was not significant for minutes of exercise, $F(1, 7) = 0.53, p = .49$, frequency of exercise bouts, $F(1, 7) = 0.48, p = .51$, or MET, $F(1, 7) = 0.22, p = .66$. As well, the effect for condition from pre to follow-up was not significant for minutes of exercise, $F(1, 7) = 0.46, p = .52$, frequency of exercise bouts, $F(1, 7) = 0.56, p = .48$, or MET, $F(1, 7) = 0.33, p = .58$. Lastly, the effect for the Condition x Time interaction was not significant in minutes of exercise, $F(1, 7) = 0.85, p = .39$, $d = 0.59$, frequency of exercise bouts, $F(1, 7) = 0.48, p = .51$, $d = 0.46$, or MET, $F(1, 7) = 1.36, p = .28$, $d = 0.75$. Again, despite no significant results, effect sizes for minutes of exercise and frequency of exercise bouts are indicative of medium effects, and the effect size for MET is indicative of a large sized effect, all demonstrating greater increases in exercise in the SM condition compared to the CON condition.
3.4.2.1.2 *Independent exercise.* In independent exercise, from pre to post, there was not an effect of time for minutes of exercise, $F(1, 7) = 0.15, p = .71,$ frequency of exercise bouts, $F(1, 7) = 0.24, p = .64,$ or MET, $F(1, 7) = 0.11, p = .75.$ The effect for condition was also not significant for minutes of exercise, $F(1, 7) = 0.19, p = .68,$ frequency of exercise bouts, $F(1, 7) = 0.43, p = 0.54,$ or MET, $F(1, 7) = 0.16, p = .71.$ Finally, the effect for the Condition x Time interaction was not significant for minutes of exercise, $F(1, 7) = 0.04, p = .84, d = 0.13,$ frequency of exercise bouts, $F(1, 7) = 0.08, p = .79, d = 0.18$ or MET, $F(1, 7) = 0.15, p = .71, d = 0.25.$ Effect sizes for independent exercise are smaller than total exercise. There was a small effect for MET demonstrating greater increases in exercise levels in the SM condition compared to the CON condition, but no effect for minutes of exercise or frequency of exercise bouts was observed.

In independent exercise from pre to follow-up there was not an effect for time in minutes of exercise, $F(1, 7) = 0.25, p = .638,$ frequency of exercise bouts, $F(1, 7) = 0.39, p = .55,$ or MET, $F(1, 7) = 0.06, p = .81.$ There was also not an effect for condition in minutes of exercise, $F(1, 7) = .74, p = .42,$ frequency of exercise bouts, $F(1, 7) = 0.94, p = .36,$ or MET, $F(1, 7) = 0.52, p = .50.$ Lastly, the effect for the interaction between condition and time was not significant in minutes of exercise, $F(1, 7) = 0.47, p = .52, d = 0.44,$ frequency of exercise bouts, $F(1, 7) = 0.21, p = .66, d = 0.30$ or MET, $F(1, 7) = 0.85, p = .39, d = 0.59.$ The effect sizes for MET and minutes of exercise were indicative of medium sized effects, and the effect size for frequency of exercise bouts was indicative of a small effect all with greater increases in exercise observed in the SM condition compared to the CON condition.

3.4.2.2 Hypothesis #4: Attendance at exercise classes and re-registration for an exercise program.
To answer secondary exercise hypotheses related to attendance rate and the proportion of participants who re-registered for an exercise program, the following tests were conducted. An independent samples t-test was used to compare the mean attendance rate between conditions. On average, participants in the SM condition attended a significantly greater percentage of classes ($M = 96.88\%, \ SD = 5.23$) than the CON condition ($M = 84.70\%, \ SD = 11.22$), $t(11) = 2.43$, $p = .03$, $d = 1.39$. This effect size is suggestive of a very large effect. A chi square test was used to assess the relationship between study condition and re-registering for a Phoenix exercise program. There was a significant association between condition and whether participants re-registered, $\chi^2(1) = 3.90$, $p = .048$. Based on the odds ratio, the odds of re-registering for a class were 12.50 times higher if participants were in the SM condition compared to the CON condition. This odds ratio signifies a very large effect for condition on whether or not participants re-registered for a class.

3.4.2.3 Hypothesis #5: Predicting exercise. Two linear regression analyses were performed to examine the relationship between self-monitoring and exercise. Self-monitoring subscale scores at week 7 were suggestive of being a predictor of total exercise minutes post program, $\beta = .61$, $\text{adj}R^2 = .29$, $F(1, 7) = 4.19$, $p = .08$, but self-monitoring subscale scores post program were not a significant predictor of total exercise minutes at 1-month follow-up, $\beta = .48$, $\text{adj}R^2 = .13$, $F(1, 8) = 2.33$, $p = .17$.

Two linear regression analyses were also conducted to examine the relationship between goal setting and future exercise behaviour. At the $p \leq .10$ level, goal setting subscale scores at week 7 were a suggestive of being a predictor of total exercise minutes post program, $\beta = .60$, $\text{adj}R^2 = .26$, $F(1, 7) = 3.86$, $p = .09$, but, similar to self-monitoring, goal setting subscale scores
post program were not a significant predictor of total exercise minutes at 1-month follow-up, $\beta = .36$, $adjR^2 = .02$, $F(1, 8) = 1.21$, $p = .30$.

**3.4.3 Hypothesis #6: Group cohesion**

To test the hypothesis regarding group cohesion ANCOVA were conducted for each of the four group cohesion subscales. Differences between conditions were assessed for the outcomes IAG –task, IAG –soc, GI –task, and GI –soc at post, while controlling for baseline scores. Baseline scores were controlled for because there were significant differences between conditions at this time point. Cohen’s $d$ effect sizes were calculated on the difference scores between pre and post for each subscale. Contrary to our hypothesis, there was not an effect for condition in IAG –task, $F(1, 9) = 0.46$, $p = .52$, $d = 0.21$, IAG –social, $F(1, 9) = 0.15$, $p = .71$, $d = 0.06$, GI –task, $F(1, 9) = 0.04$, $p = .86$, $d = 1.00$, or GI –social, $F(1, 9) = 0.07$, $p = .80$, $d = 0.37$.

Please see Figure 3.15, Figure 3.16, Figure 3.17, and Figure 3.18 for visual representation of group cohesion subscales between conditions.

**3.4.4 Hypothesis #7: Health related quality of life**

Health related quality of life was examined using a repeated measures (time: pre, post, follow-up) MANOVA with the outcome variables physical and mental summary scales. The overall multivariate effect for time was not significant, $F(4, 48) = 2.06$, $p = .10$. However, as outlined in our statistical plan, analyses associated with a $p$ value $\leq .10$ were worthy of further exploration. Univariate analyses revealed the effect for time was significant for the mental summary scale, $F(2, 24) = 3.51$, $p = .046$, partial $\eta^2 = .23$, but not the physical summary scale, $F(2, 24) = 2.42$, $p = .11$, partial $\eta^2 = .17$. Despite no significant effects for the physical summary score, effect sizes are indicative of large effects for both the mental and physical summary scores. Post hoc paired sample t-tests performed between each time point revealed that mental
summary scores increased from pre \((M = 43.54, SD = 11.08)\) to post \((M = 49.46, SD = 14.44)\), \(t(12) = 2.16, p = .05\), and also from pre to follow-up \((M = 49.23, SD = 13.49)\), \(t(12) = 2.26, p = .04\). Please see Figure 3.19, and Figure 3.20 for graphs depicting changes in health related quality of life.

### 3.4.5 Hypothesis #8: Physical outcomes

#### 3.4.5.1 BMI

To test the hypothesis concerning BMI a 2 (condition: CON, SM) X 3 (time: pre, mid, post) repeated measures ANOVA was conducted. The effect of time was not significant, \(F(1.23, 12.25) = 3.83, p = .07\), partial \(\eta^2 = .28\). The effect for condition was significant, \(F(1, 10) = 5.40, p = .04\), partial \(\eta^2 = .35\). Post hoc tests for condition were conducted by collapsing all time points and performing an independent samples t-test between conditions. These analyses revealed that the SM condition \((M = 39.37, SD = 3.87)\) had a significantly greater BMI than the CON condition \((M = 31.54, SD = 3.74)\), \(t(10) = 2.32, p = .043\). The interaction effect for Condition x Time was not significant, \(F(1.23, 12.25) = 0.51, p = .53\), partial \(\eta^2 = .05\). As the effect for time was associated with a \(p\) value \(\leq .10\), further exploration was warranted. Post hoc tests were conducted by collapsing conditions (since the Condition x Time interaction was not significant) and performing paired sample t-tests between all time points. These analyses revealed that BMI decreased from pre \((M = 35.11, SD = 7.01)\) to mid program \((M = 34.74, SD = 6.71)\), \(t(11) = 1.94, p = .08\), and pre to post \((M = 34.55, SD = 6.74)\), \(t(11) = 2.00, p = .07\). For graphical display of BMI please refer to Figure 3.21.

#### 3.4.5.2 Waist circumference

To test the hypothesis regarding waist circumference a 2 (condition: CON, SM) X 3 (time: pre, mid, post) repeated measures ANOVA was conducted. The effect of time was significant, \(F(2, 20) = 5.74, p = .01\), partial \(\eta^2 = .37\). The effect for condition was not significant, \(F(1, 10) = 1.96, p = .19\), partial \(\eta^2 = .16\), nor was the effect for the
interaction between condition and time, $F(2, 20) = 0.03, p = .97$. Post hoc tests for the effect of time were conducted by collapsing conditions and performing paired sample t-tests between all time points. Similarly to BMI, waist circumference decreased from pre ($M = 109.73, SD = 18.86$) to mid program ($M = 107.21, SD = 16.58$), $t(11) = 3.04, p = .01$, and also from pre to post ($M = 106.69, SD = 16.71$), $t(11) = 2.64, p = .02$. For graphical display of waist circumference please refer to Figure 3.22.

3.4.5.3 Resting heart rate. To test the hypothesis for resting heart rate, a 2 (condition: CON, SM) X 3 (time: pre, mid, post) repeated measures ANOVA was conducted. The effect for time was not significant, $F(1.31, 13.12) = 0.70, p = .46$, partial $\eta^2 = .07$. Nor was the effect for condition, $F(1, 10) = 0.61, p = .45$, partial $\eta^2 = .06$, or the Condition x Time interaction, $F(1.31, 13.12) = 0.61, p = .49$, partial $\eta^2 = .06$. For graphical display of resting heart rate please refer to Figure 3.23.

3.4.5.4 Six-min walk test. To test the hypothesis regarding aerobic fitness an ANCOVA was performed for the 6-min walk test scores post program, using baseline scores as the covariate. This was done because there were significant group differences at baseline in the 6-min walk test. Cohen’s $d$ was calculated using the difference score between pre and post. The effect for condition was not significant, $F(1, 10) = 1.38, p = .27, d = .88$. Please see Figure 3.24 for a graph displaying aerobic fitness between conditions.

To test whether there was an effect for time, conditions were collapsed and a paired samples t-test was performed from pre to post program. This test revealed that there was a significant increase in meters walked during the 6-min walk test from pre ($M = 375.23, SD = 118.65$) to post ($M = 478.53, SD = 126.84$), $t(12) = 1.78, p = .01$. 
3.4.6 Hypothesis #9: Blood Glucose

To test hypotheses related to BG, two repeated measures ANOVA (time: pre, mid, post) were conducted for the outcome variables mean BG and MAGE across the 8-week program. Participants in the SM condition only were included in these analyses because the data was obtained from the CGM and participants in the CON condition did not wear the CGM. The effect for time in mean BG was not significant, $F(2, 8) = 1.10, p = .38$, and neither was the effect for time in MAGE, $F(2, 8) = 0.07, p = .93$.

3.5 Qualitative Analyses

3.5.1 Salient topics

Themes that emerged regarding information from the intervention that participants found most salient are compared between the CON and SM conditions below.

3.5.1.1 “What I have learned...” One participant in the CON condition recalled learning that sleep is important and another participant said he learned that “I go to exercise and my blood sugar goes up.” All other participants in CON reported not being able to recall anything they had learned. Conversely, in the SM condition multiple themes emerged from participants’ responses. The most frequent response was that participants learned the importance of exercise ($n = 3$). Specifically participants spoke to exercise’s ability to lower BG; “Well, just the learning of wearing that monitor, and how exercise can bring down the diabetes and that.” As well, participants recalled learning how to plan for exercise ($n = 1$), patterns of BG fluctuation across the day ($n = 1$), the importance of eating healthy ($n = 2$) and, falls prevention ($n = 1$).

3.5.1.2 “What I incorporated into my life...” Participants in both conditions commonly cited exercise as something that they have incorporated into their own lives (CON [$n = 3$], SM [$n = 4$]). A major difference between conditions was that, in the CON condition, participants
explained that they tried to exercise more, where as in the SM condition, participants spoke specifically about trying to exercise most days of the week. For example one participant in SM describes, “Well I’m trying to do more exercise, I try to do something everyday… I’m at the pool three times a week but not on the weekends so I try and go out for a 20-minute pole walk.” Other comments of components that participants incorporated into their lives in the CON condition included using a pedometer to track steps ($n = 1$), and in the SM condition included eating better ($n = 1$) and an improved walking technique to prevent falls ($n = 1$).

3.5.2 CGM feasibility

The next section is a presentation of participants’ comments regarding the feasibility of wearing CGM. Topics include what participants liked about the CGM, how much it interfered with daily life, ease of use and suggestions for improvement. Three participants said they would wear the CGM again, two participants said they would wear it again if the device could be inserted subcutaneously and one participant said he would not wear the device again.

3.5.2.1 Benefits. The CGM allowed participants to view their BG levels constantly throughout the day and all participants were in agreement that this was important. Participants’ comments highlight that the ability to see their BG was convenient, informative and reassuring. For example, one participant with T2D explains,

“It took away a lot of my anxiety in the middle of the night of monitoring myself to make sure I didn’t go into diabetic lows… it helped me, it gave me reassurance, especially because my levels are all over the place and so it helped me realize if I was high or low… But most importantly is when I go into the lows, because there’s always concern of diabetic coma… and I
certainly in the past have ended up in the hospital at least 3 times because of it in the middle of the night”

In comparison to traditional BG monitoring participants describe the CGM as beneficial because when wearing it they do not have to perform as many painful finger prick blood samples.

3.5.2.2 Interference with daily living. Issues identified as interfering with normal activities of daily life included interrupted sleep due to the monitor beeping \((n = 1)\), difficulty when showering \((n = 1)\), and not being able to go in the hot tub \((n = 1)\).

3.5.2.3 Ease of use. All participants said that they had no trouble understanding the BG graphs created by the CGM devices. Participants also reported no difficulty using the CGM (e.g. knowing which buttons to press). In general though, participants found it much easier to use the second and third time they wore it; “I wasn’t used to it the first time, but then by the second time it was easier and the third time was good.”

3.5.2.4 Suggestions for improvement. Having to reset the CGM after 3 days was stated as a negative aspect for many participants \((n = 3)\); “We had to reset it on the third day and that and couldn’t they make a machine that you didn’t have to.” Other suggestions for improving the devices included making the monitor smaller \((n = 2)\), creating a CGM that is inserted under the skin \((n = 3)\), having a waterproof monitor \((n = 1)\), and making the speakers on the monitor face-up when the device is in its belt holster \((n = 1)\). Lastly, one participant noticed that when the BG readings were past an upper limit they no longer showed up on the monitors and she would suggest increasing this upper limit, as high as 30 mmol/L, so that it is congruent with the glucometers. An anticipated issue with the devices was that they would be painful, however,
multiple participants confirmed that this was not the case; “I didn’t notice it was there… it was painless when it was installed, it was painless when it came off.”

3.5.3 Using CGM to self-monitor.

3.5.3.1 Value for behaviour change. A reoccurring theme that emerged was that the BG feedback from the CGM was a valuable tool for influencing decisions regarding diet and exercise. The majority of participants said that seeing the BG graphs in response to what they were eating really impacted the foods they chose to eat ($n = 5$). One participant explains, “It was good to see it right in front of you, you couldn’t deny it, the evidence was right there,” and when asked if it had a meaningful impact on her life choices she replied, “Yeah, don’t eat gummy bears.” Two participants said that observing improvement in their own BG control following exercise made them consider exercising more days of the week; “On the weekend when I have 2 days off from exercising I did know my BG went up a bit… so I noticed that… I could have gone out for a walk”

3.5.3.2 Tips to make self-monitoring easier. Participants provided suggestions for strategies to help people who are struggling with self-monitoring BG including, i) incorporating it into a regular routine, ii) recruiting a family member for support, and iii) recording entries right away. The most commonly occurring suggestion was that it is easiest to remember to self-monitor when it was part of a routine; “It was not difficult when I sat down to eat breakfast… my breakfast routine is very ingrained and the logbook was right beside my table.”
Chapter 4: Discussion

Regular exercise provides vast health benefits and may be particularly beneficial for people with T2D or prediabetes (Colberg et al., 2010; Tuomilehto et al., 2001). Regardless of these benefits the Canadian population is largely inactive (Statistics Canada, 2013). People with T2D are even less active than their non-diabetic peers (Morrato et al., 2007). The goal of the present study was to test the feasibility of a self-monitoring intervention at increasing exercise levels in a sample with prediabetes or T2D. The primary outcomes tested were self-monitoring and goal setting behaviours, self-efficacy to self-monitor, and exercise levels. Secondary outcomes included group cohesion, HRQL, and fitness parameters.

Overall, findings supported our self-monitoring intervention as a practical approach to increase self-monitoring and goal setting behaviours as well as self-efficacy to self-monitor. Furthermore, there were medium effects of condition for exercise directly post intervention and after a 1-month follow-up period, whereby participants in the self-monitoring intervention (SM) condition reported higher levels of exercise than those in the standard of care exercise condition. In both conditions, HRQL and fitness increased, and BMI and waist circumference decreased from pre to post exercise program. Potential explanations and implications of these results are offered below.

4.1 Self-monitoring and Goal Setting

There is extensive documentation of theoretically based interventions for health behaviour change (Dishman & Buckworth, 1996; Michie, Abraham, Whittington, McAteer & Gupta, 2009). A review of the theoretical frameworks used in previous exercise interventions found that SCT was the primary theory employed and also the most successful at eliciting positive changes in exercise behaviour (Conn, Minor, Burks, Rantz & Pomeroy, 2003). From the
perspective of SCT, there are five constructs that need to be targeted to promote behaviour change: knowledge, self-efficacy beliefs, outcome expectations, self-regulation and barriers (Middleton et al., 2013). Behavioural interventions utilize strategies to target these constructs (e.g., teaching self-monitoring to assist in self-regulation of exercise behaviour). Typically interventions have incorporated a combination of multiple behaviour change strategies with few to no attempts to dissect which strategies lead to any subsequent changes in behaviour (Dunn et al., 1999; Kirk et al., 2004; Kirk et al., 2009). As a result there is very little research that focuses on the effectiveness of individual strategies such as self-monitoring. In order to increase the impact and efficiency of future exercise interventions it is vital to first identify which strategies are most useful in changing behaviour. In 2003, a review by Conn and colleagues expressed the need for more empirical research to systematically isolate each strategy, yet there has been little progress on the topic.

A second gap in the literature of theoretically based exercise interventions is the lack of quantification of change in the proposed mediating variables. Interventions are designed to effect change in exercise behaviour through strategies that target mediating variables (e.g., self-regulation skills). However, many studies do not report the degree of change in these mediating variables as a result of the intervention. This leaves us ignorant as to the intervention’s ability to produce changes in the mediating variables of interest (Baranowski, Lin, Wetter, Resnicow & Hearn, 1997). It also means that the use of these strategies cannot be linked to the observed changes in exercise behaviour, again limiting our ability to determine which strategies are most effective.

The present research tested an intervention aimed at increasing self-monitoring and goal setting behaviour. In the present research, we demonstrated important and significant increases in
self-monitoring and goal setting skills in individuals who received the self-monitoring intervention, but not individuals who received the standard of care exercise intervention. This speaks to the success of the self-monitoring intervention at eliciting change in the mediators of interest. These increases were apparent after a tutorial focused on teaching these two skills, and remained increased for the remainder of the 8-week intervention. In contrast, in the standard of care exercise condition, use of self-monitoring and goal setting skills did not change across the 8-weeks. The use of relapse prevention skills, which were not targeted in the current intervention, did not differ between conditions. This demonstrates how there are not changes in use of skills that are not taught and that there does not appear to be a natural progression to adapt and use self-regulatory skills not specifically taught or targeted. As such, we are confident that this intervention successfully isolated the effects of using self-monitoring and goal setting skills, and that it was successful at improving self-monitoring and goal setting skills.

Similar to our findings, Hallam and Petosa (2004) describe a SCT based intervention that focused on increasing self-regulatory skills in conjunction with other behaviour change strategies. Following four 1-hour instructional sessions in their study, participants’ use of self-regulatory skills (including reinforcements, social support, goal setting, self-monitoring, time management, and relapse prevention) had increased in the intervention group compared to a control group. Ours is the first study to demonstrate that use of self-monitoring and goal setting can be increased with a single, brief 45-min tutorial as verified by increases in self-monitoring and goal setting subscale scores from week 2, prior to the tutorial, to week 4, following the tutorial. Furthermore, it appears that increases in these two skills can be sustained with periodic group discussions and check-ins by the researcher.
The most important aspect of self-monitoring when it comes to changing exercise behaviour, however, is the frequency that one self-monitors (Helsel et al., 2007). Apart from baseline measures, the SM condition had a greater frequency of self-monitoring exercise than the standard of care exercise condition at all assessment points during the 8-week intervention (week 4, week 5, week 7, and post). Frequency of self-monitoring BG also increased in the SM condition following each period participants wore the CGM, albeit not significantly. Although some study participants were already using blood prick assessments to monitor their BG, many were not and did not have access to monitoring equipment outside of the three CGM sessions (particularly people with prediabetes). Therefore the observed pattern of increases and decreases in frequency of BG monitoring across the intervention were expected. The standard of care exercise condition did not experience increases in self-monitoring across the program. Overall these results provide further support that the intervention was successful at increasing self-monitoring behaviour as intended.

Despite these increases in self-monitoring frequency during the intervention period there was a decrease from post program to 1-month follow-up: frequency of self-monitoring in the SM condition decreased from an average of 6 times per week at the end of the 8-week intervention to less than 3 times per week at 1-month follow-up. Furthermore, the frequency of self-monitoring at the 1-month follow-up time period in the SM condition was no longer significantly different from the standard of care exercise condition. Interestingly, the same pattern did not follow with scores on the self-monitoring subscale, as demonstrated by high scores maintained at follow-up in the SM condition. Thus, despite a lower frequency of self-monitoring exercise, participants still felt like they were using self-monitoring strategies as often as they were during the intervention. Qualitative data also demonstrates that participants valued the use of self-
monitoring in their lives even after the intervention ended; “Well I found [the logbooks] very helpful because I don’t write down what I do normally, so that was a good idea, to be able to write it down… which I continue to do.”

One of the few other studies to assess self-monitoring frequency as an outcome was a pedometer intervention that provided participants with logs to record their daily step count (Tudor-Locke et al., 2004). Tudor-Locke and colleagues found that the percentage of days participants reported their step count dropped from 100% during the intervention to only 58% during the last 4-weeks of an adherence phase, similar decreases as in the present study. Due to the design of our study it is impossible to decipher whether decreases in self-monitoring led to a decrease in exercise behaviour or whether a decrease in exercise resulted in less exercise bouts to self-monitor. To detect this relationship in future studies, researchers could instruct participants to record exercise levels everyday and to record zero if they did not exercise. Then, by logbook analyses researchers could determine whether participants stopped self-monitoring exercise bouts or whether there were less exercise bouts to self-monitor. Based on logbook analyses for goal setting and the percentage of exercise minutes tallied, it is apparent that these self-regulatory skills were not being used as regularly during follow-up in the present study.

Previous group mediated cognitive behavioural (GMCB) interventions have integrated a transitional period into their program whereby the number of exercise class sessions and group meetings slowly decreased and contact with the researcher was gradually reduced as the program progressed (Brawley et al., 2000; Rejeski et al., 2003). This was done to decrease participants’ dependence upon the group for exercise and to instead promote independent exercisers. In the current study we did not have control over scheduling of the class sessions as this was decided by the staff at Phoenix Health and Fitness. We did, however, attempt to transition participants by
encouraging them to increase the number of independent exercise bouts they were performing as the end of the program drew closer. We also provided participants with a new logbook to continue self-monitoring and goal setting during the 1-month follow-up period. Future studies should consider more ways to successfully shift participants from dependence on the exercise group and the researcher into an independent exerciser. It may be beneficial, for example, to include a short transitionary period with increased participant-researcher contact time after the exercise program has ended. This could include telephone or mail correspondence checking in with participants to see if they have maintained use of the selected self-regulatory skills and to troubleshoot any barriers that may have evolved since they have been using these skills on their own.

4.2 Self-efficacy to Self-monitor

Self-efficacy is theorized to be one of the strongest predictors of future behaviour (Bandura, 1977). Empirical findings show that self-efficacy can accurately predict intentions to exercise and exercise behaviour (McAuley & Courneya, 1993; Rodgers & Brawley, 1993; Sniehotta et al., 2005). In addition to forming an intention there are self-regulatory behaviours that must occur prior to engaging in an exercise bout (e.g., planning, overcoming barriers such as weather). Therefore it is logical that self-regulatory forms of self-efficacy also play an important role in exercise behaviour (DuCharme & Brawley, 1995).

The present study examined a form of self-regulatory self-efficacy: self-efficacy to self-monitor. This was most appropriate since the aims of the intervention were to teach participants how to self-monitor. Findings were supportive of our hypothesis; the SM condition had greater increases in self-efficacy to self-monitor exercise compared to the standard of care exercise condition. Self-efficacy theory stipulates performance accomplishments and vicarious experience
as the two most potent sources for self-efficacy (Bandura, 1977). Therefore it is not surprising that there were higher levels of self-efficacy for participants in the SM condition, since they were provided opportunities to practice self-monitoring their exercise and to listen to their peers’ self-monitoring experiences during group discussions. Interestingly, group differences in self-efficacy to self-monitor exercise over time appear to be the result of not only an increase in self-efficacy in the SM condition but also a drop in self-efficacy in the standard of care exercise condition. This decline in self-efficacy in the control group is consistent with findings in other studies (Gleeson-Kreig, 2006; Speck & Looney, 2001). It has been speculated that initial assessments of self-efficacy are often overestimated given that participants have not yet had a chance to experience the barriers associated with the behaviour. Therefore a drop in self-efficacy often occurs once participants begin the new behaviour and actual barriers are met. Participants recruited for this study were novice exercisers and it is quite plausible that they had never attempted to self-monitor their exercise behaviour before, thus resulting in an overestimation at baseline. It is likely that the SM condition also overestimated their self-efficacy at baseline, but as a result of the intervention self-efficacy still increased.

Despite evidence consistently demonstrating that self-regulatory efficacy is the strongest form of self-efficacy to predict future exercise behaviour, it still remains more common for exercise interventions to assess task self-efficacy (e.g., self-efficacy to perform the exercise; Rodgers & Brawley, 1993; Marcus, Eaton, Rossi & Harlow, 1994; Marcus, Selby, Niaura & Rossi, 1992; McAuley & Courneya, 1993; McAuley & Jacobson, 1991). A study assessing different types of self-efficacy during a cardiac rehabilitation program, for example, found that self-regulatory self-efficacy (i.e., scheduling self-efficacy) accounted for more variance in attendance to the exercise program than task self-efficacy (i.e., walking self-efficacy; Woodgate
et al., 2005). The sample in Woodgate and colleagues’ study was very similar to that of the current study, namely beginner exercisers with chronic disease, however the same results have been found in asymptomatic populations as well (DuCharme & Brawley, 1995; Rodgers & Sullivan, 2001). In the current study the SM condition, which had greater self-monitoring self-efficacy levels, also had higher attendance rates. There was not however any significant difference in total or independent exercise levels between the two conditions. Lifestyle changes are complex and it often takes time for behaviour change to transpire. The observed increases in self-monitoring and goal setting behaviour along with increases in self-efficacy to self-monitor are notable on their own and, if sustained, may lead to beneficial lifestyle changes in the longer-term.

Contrary to our second self-efficacy related hypothesis, there were no differences between conditions for self-efficacy to monitor BG. This may be due to the very small sample size used in these analyses (standard of care exercise condition [n = 3], self-monitoring intervention condition [n = 3]). Participants with prediabetes and some participants with T2D did not have any experience self-monitoring their BG and therefore were not able to answer BG related self-efficacy questions. Participants were provided an alternative option to these questions, as they could answer “not applicable”. Those who did respond to the questions had experience self-monitoring BG and most were regularly self-monitoring their BG at the time of the study. This may make results more conservative because the opportunity to self-monitor BG was not unique to the SM condition, as it would be if people with prediabetes were included. However, there still appears to be a trend whereby self-efficacy for self-monitoring BG increases in the SM condition and decreases in the standard of care exercise condition and the effect size for the interaction was large (partial $\eta^2 = .28$). Perhaps the use of the CGM and receiving a
logbook to record BG values, in combination with group discussions about everyone’s experiences self-monitoring their BG levels may have led the SM condition to have higher self-efficacy to self-monitor BG than the standard of care exercise condition. More research is needed with a larger sample size to confirm these findings.

4.3 Exercise

Findings in the 7-day Physical Activity Recall Questionnaire (PAR) derived exercise variables revealed success of the SM intervention at increasing exercise levels post program and exercise adherence at 1-month follow-up. There were medium sized effects for changes in total minutes of exercise and total MET at post program and follow-up between conditions, wherein participants in the SM condition (GMCB-structured) reported greater increases in exercise. More predominant effects of condition were evident at follow-up than directly post intervention, consistent with previous GMCB interventions (Brawley et al., 2000; Rejeski et al., 2003). The biggest advantage of GMCB interventions compared to standard exercise programs is that they help participants maintain exercise levels once the structured exercise program has ended. A particularly noteworthy trend in the SM condition was an increase in minutes of independent exercise from post to follow-up (please see Figure 3.12). Despite total minutes of exercising decreasing once the structured exercise classes had ended, participants in the SM condition were doing more exercise on their own than they had been during the intervention. In the standard of care exercise condition, however, independent minutes of exercise decreased from post to follow-up.

Attendance to the exercise classes, a secondary indicator of exercise levels, was also higher in the SM condition than the standard of care exercise condition. Focht and colleagues (2004) found the same result in their GMCB intervention. Drop out rates for exercise programs
in populations with chronic disease typically range from 40-50% within the first 6 to 12 months (Oldridge, 1988). Intervention models that promote high attendance rates therefore may be quite valuable. Unique in the present study we measured whether participants signed-up for another program at the exercise centre by 1-month follow-up. Committing to an exercise program by registering is an indirect measure of an intention to continue exercising. We found that the odds of re-registering for an exercise program at Phoenix health and fitness were approximately 12 times higher if participants were in the SM condition as compared to the standard of care exercise condition.

The current study is the first to our knowledge that has tested a GMCB structured exercise intervention for people with T2D or prediabetes. Previous interventions for people with T2D that only provided participants with physical activity guidelines or prescribed daily step count goals in conjunction with use of a pedometer were largely ineffective at improving adherence to exercise (Tudor-Locke et al., 2004; Uusitupa, 1996). It is apparent that these styles of intervention did not provide the motivation or the necessary self-regulation skills training for maintenance to an exercise regimen to occur post intervention. There are relatively few exercise interventions that use cognitive-behavioural strategies in an attempt to improve exercise adherence in people with T2D or prediabetes, despite recommendations of their success in other populations (Meichenbaum & Turk, 1987). Di Loreto et al. (2003), and Kirk et al. (2004) demonstrated successful interventions for increases in exercise adherence at 1-, and 2-months, respectively. Both of these study designs involved cognitive-behavioural strategies similar to those used in the present study (e.g., self-monitoring, goal setting, overcoming barriers, increasing self-efficacy, etc.). In contrast to the present study, however, these two studies were conducted using one-on-one counseling sessions and did not include an exercise instructional
component. Group based interventions may be more time and cost efficient. As well, through the opportunity for social interactions a group setting may provide mental health benefits in addition to physical benefits. In the present study participants’ perceived mental health increased in both conditions, and previous studies have found increases in perceived social functioning following a group-based exercise class (Bailey, Currie, MacDonald, McKelvie & Jung, 2013; Lavorato, Grypma, Spenceley, Hagen & Nowatzki, 2003). Furthermore, by implementing the current study during an exercise program, we have shown that in addition to a traditional counselor-patient setting an exercise class might be an advantageous setting to teach self-monitoring and goal setting skills.

To our knowledge this is the first study to isolate the teaching of self-monitoring and goal setting during an exercise program. The large effect witnessed between conditions at follow-up for exercise levels suggests that these two self-regulatory skills alone may be effective at promoting increased adherence to exercise. Furthermore, self-monitoring and goal setting were significant predictors of exercise minutes post program. In line with our findings, meta-analyses of health behaviour change interventions have found that self-monitoring is the component of behavioural interventions most commonly associated with improved effectiveness at increasing health behaviour (Conn, Valentine & Cooper, 2002; Michie et al., 2009). Due to low statistical power in the present study, we chose a priori not to test for mediation effects, but we would strongly urge future studies to test the mediational utility of self-monitoring and goal setting at increasing independent exercise in this population.

Despite these promising effect sizes that suggest the SM condition may be more successful at increasing exercise and adherence to exercise than the standard of care exercise condition, there were no significant changes or interactions in any of the 7-day PAR derived
exercise variables across time (minutes of exercise, frequency of exercise bouts, MET). This is likely partly a result of insufficient statistical power, as the total sample size included in these analyses was only 9.

Another limitation, however, may have been the use of the 7-day PAR as the primary assessment of changes in exercise behaviour in this sample. A review of the challenges associated with measuring exercise in adults who are typically sedentary identified multiple issues surrounding the use of a self-report exercise questionnaire in this population (Tudor-Locke & Myers, 2001). For example, when using the 7-day PAR questionnaire to measure exercise, activities sustained for less than an accumulated 10-min are not included, yet many of these activities at the lower end of the exercise continuum are characteristic of previously sedentary adults (Tudor-Locke & Myers, 2001). This floor effect means that the lowest possible rating of exercise is still too high for some participants. One example of this in the current study occurred when a participant had not completed any activities that could be considered inclusive of exercise by 7-day PAR guidelines, but she felt that she had been exercising more because she had been using canes instead of her walker when moving. For future research Tudor-Locke and Myers’ review (2001) suggests that motion sensors may be the most effective method. Despite their own drawbacks, including cost, use of motion sensors may solve the aforementioned limitations of self-report questionnaires.

4.4 Group Cohesion

Higher perceptions of group cohesion typically lead to greater adherence to exercise classes (Estabrooks, 2000). A primary objective in GMCB interventions is to foster an environment of cohesion within the exercise group. In the present study, reported feelings of group cohesion following the 8-week exercise program did not differ between conditions despite
one condition receiving a GMCB structured intervention and the other receiving standard care. Group cohesion outcomes are not reported in many previous GMCB intervention studies. Albeit one study that measured cohesion for intervention fidelity purposes but did not compare cohesiveness between conditions (Cramp & Brawley, 2009). This study found that following the GMCB intervention perceptions of group cohesion were high in the treatment condition (Cramp & Brawley, 2009).

A possible explanation for why there were not any differences in group cohesion between conditions could be that the exercise program itself was quite successful at creating an environment of high group cohesion. This speculation is supported by the high scores on group cohesion subscales in both conditions, with all but one group cohesion subscale at least 70% of the maximal attainable score by the end of the intervention (GI–soc was only 62% of the maximal attainable score in the standard of care exercise condition). Therefore, despite no differences between conditions, feelings of group cohesion in the SM condition were high. This type of established community setting thus may be ideal for the implementation of a GMCB intervention.

4.5 HRQL

There is no cure for people living with chronic disease. As such, quality of life is a particularly important treatment outcome. People with diabetes have reported lower ratings of quality of life than those without chronic disease and therefore this may be a population that needs extra research attention to find strategies that can increase HRQL (Rubin & Peyrot, 1999). In the present study, following the 8-week exercise program, the mental health summary scale increased but the physical health summary scale did not.
There are conflicting results in the literature regarding whether exercise interventions can increase HRQL, there are interventions that have produced changes in both mental and physical components of HRQL and others that have not (Arthur et al., 2007; Bailey et al., 2013; Duarte Freitas et al., 2011; Mereles et al., 2006; Thomas, Elliott & Naughton, 2006). The high variability in results is likely due to the diversity of intervention designs and delivery of the programs. Group cohesion scores in the present study were very high in both conditions and this may have contributed to increases in the mental component summary scale, as one subscale of mental health is social functioning. Rates of depression are especially high in people with diabetes (24% versus 17% in the general population) and an exercise program that can improve perceived mental health therefore has meaningful implications (Goldney, Phillips, Fisher & Wilson, 2004). Future research should attempt to determine which aspects of exercise programs are most important for eliciting increases in perceived mental health.

There are, however, fairly unanimous results that higher levels of physical activity are associated with higher HRQL scores, for both the physical and mental components (Chyun et al., 2006; Glasgow, Ruggiero, Eakin, Dryfoos & Chobanian, 1997; Rejeski et al., 2006). It was surprising that there were not significant increases in the physical component summary, especially after analysis of the qualitative data where many participants spoke of the physical improvement they felt they had achieved. For example, one participant in the SM condition expressed the benefit she received from the program and the meaning that these changes had for her:

“I like to be able to do the exercises and seeing how much better I am getting. How much stronger I am getting, how much more flexible I am becoming. Being able to graduate from only working in a chair, to
working behind a chair and only near a chair and then kind of all there on my own. I do not like to look at myself in the mirror. I don’t like to see, other people seeing my face. Even in these 8 weeks, I think I improved.”

The lack of significant increases was likely a result of low statistical power. There appeared to be a trend toward improvement and the corresponding effect size was medium (partial $\eta^2 = .17$).

**4.6 Physical Outcomes**

In both conditions there were improvements in BMI and waist circumference at the end of the 8-week exercise program. These findings are largely in contrast with previous studies, as reported in meta-analyses, which found only modest to non-significant changes in BMI and waist circumference produced by exercise interventions (Boulé et al., 2001; Thorogood et al., 2011). It has been thought that without the addition of dietary or drug interventions, exercise alone cannot create enough of an energy deficit to lead to anthropometric changes (Sigal, Kenny, Wasserman, Castaneda-Sceppa & White, 2006). Our results suggest otherwise, but also, are a testament that the exercise classes provided must have been led at a relatively high intensity for participants. Aerobic fitness levels also improved from pre to post program in both conditions. In combination, findings for these three physical outcomes provide strong support that despite no significant effects of time for exercise when assessed with the 7-day PAR, participants in both conditions were probably engaging in increased levels of exercise from pre to post program. It would be unlikely to observe such improvements in BMI, waist circumference and, especially, fitness without a change in exercise patterns.

There were not, however, any group differences for changes in physical outcomes. Our original hypothesis was that participants in the GMCB intervention would experience greater
improvement in physical outcomes than the standard care condition on account of their exercising more. However, these physical outcomes were assessed only at the end of the program and not at follow-up. There may have been small differences in exercise levels among conditions post program, but at this time it is assumed that the majority of the exercise that participants were performing was during the classes and, therefore, would not be different between conditions. The major advantage of GMCB based interventions is higher adherence to exercise following the end of the structured exercise program. Therefore, it would be more reasonable to have hypothesized that the SM condition would see greater change in physical outcomes at follow-up rather than post. In support of this thinking, a GMCB intervention conducted by Brawley and colleagues (2000) found equal improvement in metabolic capacity between a GMCB intervention group and a standard exercise treatment group directly following an intervention phase, but greater improvement in metabolic capacity in the GMCB group after a 3-month follow-up period.

4.7 Blood Glucose

BG regulation did not change across the course of the 8-week exercise program. Despite our hypothesis that average BG levels and BG variability would improve, we did not instruct participants to create BG related targets or to adjust their behaviour to better control their BG. Our hypothesis was based upon the premise that participants would be exercising more by the end of the program than they had been at the start and this should result in better BG regulation. However, regardless of changes in exercise, we did not control for diet, and diet has a large impact on BG regulation (Jenkins et al., 1981). Furthermore, the second time that participants wore the CGM happened to fall across Thanksgiving long weekend, and the third time participants wore the CGM occurred during Halloween. Holidays typically involve consumption of more high-sugar foods that have a detrimental impact on BG regulation (Klesges, Klem &
Bene, 1989). This speculation is supported by qualitative data. For example, one participants recalled, “We had to wear [the CGM] over Halloween and of course I ate candy and I do- and but it was good to see that, you know, how the sugar would make the, you know, makes your diabetes go up.”

4.8 CGM feasibility

A novel component to this study was testing the usability of CGM as a tool to change exercise behaviour. There is only one other study that has done this (Allen et al., 2009) and our study was unique in that we used real-time CGM instead of blinded devices and included participants with prediabetes in addition to those with T2D. The real-time CGM are more complicated to operate than the blinded CGM yet participants did not have any difficulties using them.

There was only one participant with prediabetes in the condition that wore the CGM. It is therefore difficult to conclude whether CGM interventions are as effective in this population as in people with T2D. In this scenario the CGM may not have been as beneficial for the individual with prediabetes. Despite having BG levels that put her at risk of developing T2D, she felt that her BG was normal because she compared her values with her fellow classmates who had T2D. It may be more effective to conduct separate group discussions for people with prediabetes versus those with T2D in future interventions.

Overall, in agreement with findings by Allen and colleagues (2009) participants strongly valued the BG information that the CGM provided and reported that it had a positive impact on their choices with respect to exercise and diet. To quote one participant, “When there were spikes, the spikes were at a specific time every day, which for me was the 2 hours after breakfast… so that encouraged me to make some changes and when I added stronger protein, the
spike was reduced and that was also encouraging… I can see that being able to actually see that after breakfast, my first meal of the day, was the one that pushed my blood sugars up the highest, the fastest… I should also probably include some physical stuff. Whether it’s running around the block. I don’t run anywhere, but you know, walking around right after I ate.”

4.9 Strengths

This study has a number of strengths. Firstly, it is one of the only studies to isolate the effects of self-monitoring and goal setting during an intervention, by specifically teaching these two skills and assessing if they result in improved adherence to exercise. Furthermore, it is among few studies that have quantified changes in these process variables (self-monitoring and goal setting) following the intervention. As discussed, it is vital for future health promotion programs to understand the independent effects of each behavioural change strategy. This way, exercise interventions can be designed to be effective and efficient by targeting only self-regulatory strategies demonstrated to influence future exercise behaviour.

Secondly, it was the first study to use a GMCB structured intervention in an attempt to change exercise behaviour in people with T2D and prediabetes. This population faces many challenges adopting an exercise routine and are in desperate need of interventions that are successful at helping them change their exercise behaviour and maintain these changes. GMCB interventions have had success at producing improved exercise adherence in similar populations, thus making it a sensible intervention style to test in this population (Cramp & Brawley, 2006, 2009; Rejeski, 2003).

Thirdly, this intervention has high external validity as it was implemented within an established community exercise centre for people with chronic disease, many of whom were referred by their physician. The setting and sample were both highly representative of a typical
beginner exercise program that inactive adults with chronic disease would join in Canada. As a result, this style of intervention can be easily translated into practice in similar settings with a high likelihood of success.

4.10 Limitations and Future Directions

In addition to the strengths, there were also limitations to the present study. The most predominant limitation was that the small sample size precluded advanced statistical analyses. Due to the small sample size, for example, we did not have enough statistical power to test for mediating variables. Without these analyses we are not certain that any changes in exercise behaviour can be attributed to changes in use of self-regulatory skills. We would recommend that future research attempt to measure the processes by which changes in exercise occur by testing the use of self-regulatory skills as a mediator variable in a larger sample. This study was a priori designed and funded as a feasibility study. The promising initial findings suggest that there would be merit in conducting this study again and including more participants to confirm preliminary results.

Secondly, the very low basal levels of exercise reported by participants were not anticipated by the researchers. Consequently, the exercise measurement tool selected (7-day PAR questionnaire) may not have been sensitive enough to detect changes in exercise following the intervention. Future research evaluating exercise interventions for people with T2D and prediabetes should explore a more suitable measurement tool. Tudor-Locke and Myers (2001) suggest that the use of motion sensors be used in this population as they may be more sensitive to small changes in already low levels of exercise. This limitation is explored in greater detail in the discussion section above.
A third possible limitation was the lack of a transition period between end of the intervention and the start of the follow-up period. Previous GMCB interventions emphasize a need for the number of group exercise sessions to be gradually reduced as participants begin to attempt to sustain exercise changes on their own. In the current study, scheduling of exercise classes was not under the control of the researchers. However, it would be highly beneficial for future studies to attempt to incorporate more of a transition period than was attempted in the present study. This may prevent the decreased use of self-regulatory skills that occurred during follow-up in the present study. This is described in greater detail in the discussion section.

4.11 Contributions

The present research has advanced our knowledge of the applicability of Social Cognitive Theory (SCT; Bandura, 1986) within an exercise context. Findings support the hypothesized relationship that SCT posits between use of self-regulatory skills and behaviour change. For people with T2D and prediabetes, the self-regulatory skill of self-monitoring appears to be effective for increasing and maintaining exercise behaviour change. It is unclear whether self-monitoring is more effective than targeting of other personal factors from SCT (e.g. self-efficacy, outcome expectations), as previous research interventions have not isolated and assessed these strategies independently.

Secondly, this thesis performed a thorough analysis of the feasibility of real-time CGM for people with T2D and prediabetes. This is the first study to test the feasibility of real-time CGM in people with prediabetes. In the health care setting, CGM are primarily used for people with type 1 diabetes and T2D as a way to control their insulin levels. Our findings demonstrate that use of real-time CGM, in conjunction with a self-monitoring intervention, may be useful in
people with prediabetes and people with T2D who are not using insulin as a technique to motivate lifestyle changes.

4.12 Conclusion

Exercise levels in people with prediabetes and T2D are particularly low (Chasens & Yang, 2012; Morrato et al., 2007). There has been an extensive amount of research examining exercise interventions conducted in this population. However, very few have attempted to increase adherence to exercise following cessation of a program. The purpose of this study was to test the utility of a GMCB structured intervention at increasing exercise adherence in people with T2D and prediabetes. Specifically, self-monitoring strategies were targeted as they were hypothesized to have increased saliency within this population. In addition, real-time CGM were provided to participants as a tool to assist in behaviour change. Results demonstrate that use of self-monitoring and goal setting can be successfully increased following a GMCB style intervention. Furthermore, effect sizes show that use of these self-regulatory skills may be a successful strategy to help people with T2D and prediabetes increase their exercise levels and maintain these increases following the cessation of a structured exercise program. Lastly, the use of real-time CGM is a feasible tool for interventions for people with T2D and prediabetes, and may help participants learn how to self-monitor as well as provide motivation for them to make lifestyle changes. Considering the epidemic proportions of people in Canada living with T2D or prediabetes, and the vast benefits that exercise can provide in managing these conditions, implementation of self-monitoring interventions in group-based exercise programs should be considered in communities across Canada.
Table 2.1. Participant demographic characteristics.

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<th>Self-monitoring Condition</th>
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Table 3.1. Baseline descriptive statistics for all study variables.

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<tr>
<th>Measures</th>
<th>Standard Care Group</th>
<th>Self-monitoring Group</th>
<th>Baseline Equivalency Statistics</th>
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<td>Measures</td>
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<td><strong>Self-efficacy</strong></td>
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<td>Total MET (kcal/kg)</td>
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<td>Waist circumference (cm)</td>
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<td>6-min walk test distance (m)</td>
<td>440.86</td>
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Note. Self-Regulation Scale is from Petosa (1993); 7-day Physical Activity Recall Questionnaire (7-day PAR) is from Sallis et al. (1985); MET = metabolic equivalents; Physical Activity Group Environment Questionnaire (PAGEQ) is from Estabrooks and Carron (2000); IAG –task = individual attractions to the group –task; IAG –soc = individual attractions to the group –social; GI –task = group integration –task; GI –soc = group integration –social; and Short Form 36 Health Survey (SF-36) is from Ware & Sherbourne (1992).
Figure 3.1. Illustration of participant flow.

- Spring ALCD session assigned to be standard care condition (CON)
  - 7 participants recruited for CON
  - 7 participants eligible for CON
  - 7 participants completed 8-week standard care program
- Fall ALCD session assigned to be self-monitoring intervention condition (SM)
  - 10 participants recruited for SM
  - 8 participants eligible for SM
  - 6 participants completed 8-week self-monitoring intervention program
  - 2 participants withdrew from the 8-week program. Reasons for withdrawal: job relocation (n=1), and disinterest in exercise classes (n=1)
  - 2 participants excluded due to not having impaired blood glucose

13 participants completed 1 month follow-up measures
Figure 3.2. Mean changes between conditions in self-monitoring subscale scores across the 8-week program and 1 month follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition; *p < .05; †p < .10.
Figure 3.3. Mean changes between conditions in goal setting subscale scores across the 8-week program and 1 month follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition; †p < .10.
Figure 3.4. Mean changes between conditions in relapse prevention subscale scores across the 8-week program and 1 month follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.5. Mean changes between conditions in weekly exercise self-monitoring frequency across the 8-week program and 1 month follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition; *p < .05; †p < .10.
Figure 3.6. Mean changes between conditions in weekly blood glucose self-monitoring frequency across the 8-week program and 1 month follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.7. Mean changes between conditions in self-efficacy to self-monitoring exercise across the 8-week program and 1 month follow-up. SE = self-efficacy; CON = standard care exercise condition; SM = self-monitoring intervention condition. *p < .05.
Figure 3.8. Mean changes between conditions in self-efficacy to self-monitoring blood glucose across the 8-week program and 1 month follow-up. SE = self-efficacy; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.9. Mean changes between conditions in total exercise minutes per week at pre, mid, post and follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.10. Mean changes between conditions in total frequency of exercise bouts per week at pre, mid, post and follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.11. Mean changes between conditions in total exercise MET per week at pre, mid, post and follow-up. MET = metabolic equivalent; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.12. Mean changes between conditions in independent exercise minutes per week at pre, mid, post and follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.13. Mean changes between conditions in independent frequency of exercise bouts per week at pre, mid, post and follow-up. CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.14. Mean changes between conditions in independent exercise MET per week at pre, mid, post and follow-up. MET = metabolic equivalent; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.15. Mean changes between conditions in IAG task from pre to post. IAG Task = individual attractions to the group –task; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.16. Mean changes between conditions in IAG soc from pre to post. IAG –soc = individual attractions to the group –social; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.17. Mean changes between conditions in GI task from pre to post. GI –task = group integration –task; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.18. Mean changes between conditions in GI soc from pre to post. GI –soc = group integration –social; CON = standard care exercise condition; SM = self-monitoring intervention condition.
Figure 3.19. Mean changes in the Short Form 36 Health Survey Mental Summary Score across the 8-week intervention and 1 month follow-up. *p < .05; †p < .10.
Figure 3.20. Mean changes in the Short Form 36 Health Survey Physical Summary Score across the 8-week intervention and 1 month follow-up.
Figure 3.21. Mean changes in body mass index across the 8-week program. †p < .10.
Figure 3.22. Mean changes in waist circumference across the 8-week program. *$p < .05$. 

![Graph showing mean changes in waist circumference across the 8-week program.](image)
Figure 3.23. Mean changes in resting heart rate across the 8-week program.
Figure 3.24. Mean changes between conditions in meters traveled during the 6-minute walk test between groups from pre to post. CON = standard care exercise condition; SM = self-monitoring intervention condition.
References


American Diabetes Association. (2012). Diagnosis and classification of diabetes mellitus. Diabetes Care, 35 (S1), S64-S71. doi: 10.2337/dc08-S055


Di Loreto, C., Fanelli, C., Lucidi, P., Murdolo, G., De Cicco, A., Parlanti, N., ... De Feo, P. (2003). Validation of a counseling strategy to promote the adoption and the maintenance of physical activity by type 2 diabetic subjects. *Diabetes Care, 26*(2), 404-408. doi: 10.2337/diacare.26.2.404


time continuous glucose monitoring system as a motivational device for poorly controlled type 2
Appendices

Appendix A: Measures

A.1 Demographics

1. Sex (please check one):
   - Male
   - Female

2. Year of birth: __________

3. What is the highest level of education you have completed (please check one):
   - less than high school
   - high school
   - apprenticeship or trades certificate or diploma
   - college or other non-university certificate or diploma
   - university diploma or degree
   - post-graduate degree

4. What is your occupation (please check one):
   - working full-time
   - working part-time
   - working occasionally/contract work
   - student
   - retired
   - other (please specify) __________________________
5. How do you describe yourself in terms of your ethnic origin? **Please mark the one or two groups that you feel most closely describe(s) your ethnic origin.**

- [ ] White
- [ ] Native/Aboriginal
- [ ] Chinese
- [ ] American
- [ ] Southeast Asian (e.g. Vietnamese, Cambodian, Malaysian, Laotian etc.)
- [ ] South Asian (e.g. East Indian, Pakistani, Sri Lankan etc.)
- [ ] Filipino
- [ ] Latin American
- [ ] Black
- [ ] Arab
- [ ] Korean
- [ ] Japanese
- [ ] West Asian (e.g. Iranian, Afghani etc.)
- [ ] Other (please specify): ________________________
A.2 7-day Physical Activity Recall Questionnaire

INSTRUCTIONS: Think about any physical activity you performed over the past week, beginning with yesterday (Wednesday). Please record the **TYPE** of physical activity you performed (what did you do) and the **DURATION** (how long did you do it for) in the appropriate box. Moderate activities are similar to how you feel when you are walking at a normal pace. Very hard activities are similar to how you feel when you are running, and the hard category falls in between moderate and very hard. Please only record activities that you completed for a **MINIMUM of 10 MINUTES**.

<table>
<thead>
<tr>
<th></th>
<th>Wednesday</th>
<th>Tuesday</th>
<th>Monday</th>
<th>Sunday</th>
<th>Saturday</th>
<th>Friday</th>
<th>Thursday</th>
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<tbody>
<tr>
<td><strong>MORNING</strong></td>
<td>Moderate</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Very Hard</td>
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<tr>
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<tr>
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<td></td>
<td>Very Hard</td>
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</table>

Compared to your physical activity over the past three months, was last week’s physical activity more, less or the same?

☐ More  ☐ Less  ☐ About the same
### A.3 Self-monitoring Scale

**INSTRUCTIONS:** People use various techniques to help them exercise on a regular basis. Recalling your physical exercise activities performed in the past week please answer the following questions regarding techniques you may have used to help you exercise. On the scale provided next to each item, circle the number which best represents how often you used the specified technique in the past week. Please **CIRCLE** one number for each statement. Please answer questions honestly. There is no right or wrong answer. If you have any questions, please let the researcher know.

**In the past week:**

<table>
<thead>
<tr>
<th>1. I mentally kept track of my exercise activities.</th>
<th>2. I mentally noted specific things that helped me exercise regularly.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never</td>
<td>1. Never</td>
</tr>
<tr>
<td>2. Rarely</td>
<td>2. Rarely</td>
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<tr>
<td>3. Sometimes</td>
<td>3. Sometimes</td>
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<tr>
<td>4. Often</td>
<td>4. Often</td>
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<tr>
<td>5. Very often</td>
<td>5. Very often</td>
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</table>

<table>
<thead>
<tr>
<th>3. I recorded my exercise activities in a written record.</th>
<th>4. I recorded my exercise activities in a written record including duration or intensity of exercise preformed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never</td>
<td>1. Never</td>
</tr>
<tr>
<td>2. Rarely</td>
<td>2. Rarely</td>
</tr>
<tr>
<td>3. Sometimes</td>
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<tr>
<td>4. Often</td>
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<td>5. Very often</td>
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<table>
<thead>
<tr>
<th>5. I kept a written record of specific methods used to enhance my ability to perform exercise.</th>
<th>6. I established short-term goals (daily or weekly) related to how often I exercise.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never</td>
<td>1. Never</td>
</tr>
<tr>
<td>2. Rarely</td>
<td>2. Rarely</td>
</tr>
<tr>
<td>3. Sometimes</td>
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<tr>
<td>4. Often</td>
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<td>5. Very often</td>
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<table>
<thead>
<tr>
<th>7. I established long-term goals (monthly or longer) related to how often I exercise.</th>
<th>8. I established goals for exercise time or distance (e.g., swim 20 minutes, run 3 miles).</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never</td>
<td>1. Never</td>
</tr>
<tr>
<td>2. Rarely</td>
<td>2. Rarely</td>
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<td>3. Sometimes</td>
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<td>4. Often</td>
<td>4. Often</td>
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<tr>
<td>5. Very often</td>
<td>5. Very often</td>
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</table>
9. I established exercise goals that focused on my health (e.g., improve fitness).

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10. I established exercise goals that focused on my appearance (e.g., lose weight, tone body).

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11. I established a written commitment with others to exercise regularly.

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12. I established an oral commitment with others to exercise regularly.

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13. I mentally set exercise goals.

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15. I wrote down barriers that influenced my ability to exercise.

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16. I wrote down ways to overcome barriers to exercise activities.

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17. I asked others to identify barriers to my exercise activities.

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18. I purposely planned ways to exercise when I’m on trips away from home.

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</table>

19. I purposely planned ways to exercise during bad weather.

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<th>Rarely</th>
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</tbody>
</table>
A.4 Self-monitoring questions

1. Did you record the exercise you did in the past 7 days (e.g., write on a calendar or day planner)?
   □ Yes
   □ No

2. If yes, how many times did you record your exercise in the past week?
   □ 0 days
   □ 1 day
   □ 2 days
   □ 3 days
   □ 4 days
   □ 5 days
   □ 6 days
   □ 7 days

3. Some people self-monitor their blood glucose using finger prick samples. Have you checked your blood glucose levels in the past 7 days?
   □ Yes
   □ No

4. If yes, how many times did you record your blood glucose in the past week?
   _____ times
A.5 Self-efficacy to self-monitor questions

The next few questions are going to ask you about your confidence in your ability to self-monitor, or keep track of, certain behaviours. Please **CIRCLE** the **ONE** answer that best describes how you would rate your confidence.

**In the next 7 days how confident are you that you can:**

<table>
<thead>
<tr>
<th>1. Check your blood glucose levels regularly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% Not at all Confident</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Record your blood glucose levels regularly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% Not at all Confident</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Monitor your blood glucose and adjust your behaviour accordingly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% Not at all Confident</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Record your exercise bouts?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% Not at all Confident</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Keep track of how many times you exercise and adjust your behaviour accordingly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% Not at all Confident</td>
</tr>
</tbody>
</table>
A.6 Physical Activity Group Environment Questionnaire

Living with Chronic Disease physical activity program. On the scale provided next to each item, please circle the number that best represents how much you agree with the statement. Please **CIRCLE** only one number for each statement. Please answer questions honestly. There is no right or wrong answer. If you have any questions, please let the researcher know.

<table>
<thead>
<tr>
<th>1. I like the amount of physical activity I get in this program.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Very Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. This physical activity group provides me with a good opportunity to improve in areas of fitness I consider important.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Very Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. I am happy with the intensity of the physical activity in this program.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Very Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. I like the program of physical activities done in this group.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Very Strongly Disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. I enjoy new exercises done in this physical activity group.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Very Strongly Disagree</td>
</tr>
</tbody>
</table>
6. This physical activity group provides me with good opportunities to improve my personal fitness.

<table>
<thead>
<tr>
<th>1</th>
<th>Very Strongly Disagree</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Neither Agree nor Disagree</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
</table>

7. This physical activity group is an important social unit for me.

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<tr>
<th>1</th>
<th>Very Strongly Disagree</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
</table>

8. I enjoy my social interactions within this physical activity group.

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<tr>
<th>1</th>
<th>Very Strongly Disagree</th>
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<th>4</th>
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<th>8</th>
<th>9</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
</table>

9. I like meeting the people who come to this physical activity group.

<table>
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<tr>
<th>1</th>
<th>Very Strongly Disagree</th>
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<th>4</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>Very Strongly Agree</th>
</tr>
</thead>
</table>

10. If this program were to end, I would miss my contact with the other participants.

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<tr>
<th>1</th>
<th>Very Strongly Disagree</th>
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</table>

11. In terms of the social experiences in my life, this physical activity group is very important.

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<th>Very Strongly Disagree</th>
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<th>Very Strongly Agree</th>
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12. The social interactions I have in this physical activity group are important to me.

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13. Our group is united in its beliefs about the benefits of the physical activities offered in this program.

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14. Our group is in agreement about the program of physical activities that should be offered.

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<th>7</th>
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<th>9 Very Strongly Agree</th>
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15. Members of our group are satisfied with the intensity of physical activity in this program.

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16. Members of our group enjoy helping if work needs to be done to prepare for the activity sessions.

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17. We encourage each other in order to get the most out of the program.

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<th>8</th>
<th>9 Very Strongly Agree</th>
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<td>18. Members of our physical activity group often socialize during exercise time.</td>
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<td>4</td>
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<td>7</td>
<td>8</td>
<td>9 Very Strongly Agree</td>
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<tr>
<th>19. Members of our physical activity group would likely spend time together if the program were to end.</th>
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<td>1 Very Strongly Disagree</td>
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<tr>
<th>20. Members of our group sometimes socialize together outside of activity time.</th>
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<td>1 Very Strongly Disagree</td>
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<th>21. We spend time socializing with each other before and after our activity sessions.</th>
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<td>1 Very Strongly Disagree</td>
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A.7 Short Form 36 Health Survey

The following questions are going to ask you about different aspects of your health. Please choose the ONE answer that best describes how you feel.

1. In general, would you say your health is:
   - [ ] Excellent
   - [ ] Very good
   - [ ] Good
   - [ ] Fair
   - [ ] Poor

2. **Compared to one year ago**, how would you rate your health in general **now**?
   - [ ] Much better now than one year ago
   - [ ] Somewhat better now than one year ago
   - [ ] About the same
   - [ ] Somewhat worse now than one year ago
   - [ ] Much worse now than one year ago

The following items are about activities you might do during a typical day. Does **your health limit you** in these activities? If so, how much? (Please circle **one number on each line**.)

<p>| 3. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |
| 4. 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 |
| 5. Lifting or carrying groceries | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |
| 6. Climbing <strong>several</strong> flights of stairs | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |
| 7. Climbing <strong>one</strong> flight of stairs | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |
| 8. Bending, kneeling or stooping | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |
| 9. Walking <strong>more than a mile</strong> | Yes, Limited a Lot | Yes, Limited a Little | No, Not limited at All |</p>
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</thead>
<tbody>
<tr>
<td>10. Walking <strong>several blocks</strong></td>
<td>Yes, Limited a Lot</td>
<td>Yes, Limited a Little</td>
<td>No, Not limited at All</td>
</tr>
<tr>
<td>11. Walking <strong>one block</strong></td>
<td>Yes, Limited a Lot</td>
<td>Yes, Limited a Little</td>
<td>No, Not limited at All</td>
</tr>
<tr>
<td>12. Bathing or dressing yourself</td>
<td>Yes, Limited a Lot</td>
<td>Yes, Limited a Little</td>
<td>No, Not limited at All</td>
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</table>

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

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<tbody>
<tr>
<td>13. Cut down on the <strong>amount of time</strong> you spent on work or other activities</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>14. <strong>Accomplished less</strong> than you would like</td>
<td>Yes</td>
<td>No</td>
<td></td>
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<tr>
<td>15. Were limited in the <strong>kind</strong> of work or other activities</td>
<td>Yes</td>
<td>No</td>
<td></td>
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<tr>
<td>16. Had <strong>difficulty</strong> performing the work or other activities (for example it took extra effort)</td>
<td>Yes</td>
<td>No</td>
<td></td>
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</table>

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

<p>| | | | |</p>
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</thead>
<tbody>
<tr>
<td>17. Cut down on the <strong>amount of time</strong> you spent on work or other activities</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>18. <strong>Accomplished less</strong> than you would like</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>19. Didn’t do work or other activities as <strong>carefully</strong> as usual</td>
<td>Yes</td>
<td>No</td>
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</table>

20. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

- [ ] Not at all
- [ ] Slightly
- [ ] Moderately
- [ ] Quite a bit
- [ ] Extremely
21. How much **bodily** pain have you had during the **past 4 weeks**?

- None
- Very mild
- Mild
- Moderate
- Severe
- Very severe

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

- Not at all
- Slightly
- Moderately
- Quite a bit
- Extremely

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the **ONE** answer that comes closest to the way you have been feeling. (Please circle **one number on each line**.)

<table>
<thead>
<tr>
<th>How much of the time during the <strong>past 4 weeks</strong> …</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>23. Did you feel full of pep?</strong></td>
</tr>
<tr>
<td><strong>24. Have you been a very nervous person?</strong></td>
</tr>
<tr>
<td><strong>25. Have you felt so down in the dumps that nothing could cheer you up?</strong></td>
</tr>
<tr>
<td><strong>26. Have you felt calm and peaceful?</strong></td>
</tr>
</tbody>
</table>
27. Did you have a lot of energy?

28. Have you felt downhearted and blue?

29. Did you feel worn out?

30. Have you been a happy person?

31. Did you feel tired?

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

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

How TRUE or FALSE is each of the following statements for you? (Please circle one number on each line.)

33. I seem to get sick a little easier than other people

34. I am as healthy as anybody I know

35. I expect my health to get worse

36. My health is excellent
Appendix B: Mini Mental State Examination

Mini Mental State Examination

1. What is the date? (year) (season) (date) (day) (month)
   _____ out of 5

2. Where are we? (country) (city) (part of city) (number of flat/house) (name of street)
   _____ out of 5

3. Tell the participants: “I’m now going to name 3 different objects: apple, penny, clock.”
   Now ask participants to repeat those 3 words. Give one point for each correct answer.
   _____ out of 3
   If the participants didn’t get all 3 then continue to repeat this process until they learn all 3 (for a maximum of 3 extra trials).

4. Spell world backwards. D-L-R-O-W
   Give one point for each letter correct.
   _____ out of 5

5. Ask for the 3 objects from question 3 that were repeated.
   Give one mark for each correct. (apple, penny, clock)
   _____ out of 3

6. Hold a pencil and a watch and ask participants to name each. One point for each item that was correctly named.
   _____ out of 2

7. Ask participants to repeat the following, “No ifs, ands or buts.”
   _____ out of 1

8. Ask participants to do the following. “Take a paper in your right hand, fold it in half and put it on the floor.” One point for each command that the participant does correctly.
   _____ out of 3

9. Ask the participant to read the following sentence and obey it “Close your eyes”. One point.
   _____ out of 1

10. Ask participants to write a sentence. One point
    _____ out of 1

11. Ask participants to copy the design. One point if each shape has 5 corners and 2 corners are intersecting.
    _____ out of 1

Total:
_____ out of 30
Close your eyes.

Write a sentence:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Copy this design:
Appendix C: Letters of Informed Consent

C.1 Letter of Informed Consent for the Standard Care Condition

THE UNIVERSITY OF BRITISH COLUMBIA

Consent Form

"Increasing exercise behaviour in people living with chronic diseases: A program evaluation."

Principal Investigator: Dr. Mary Jung, Assistant Professor in the School of Health and Exercise Sciences, Faculty of Health and Social Development. Phone: (250) 807-9670.

Co-Investigator(s): Ms. Kaitlyn Bailey, Master’s student in the School of Health and Exercise Sciences, Faculty of Health and Social Development. Phone: (250) 807-8419.

Emergency Telephone Number: (250) 878-6891

Introduction:
You are being invited to take part in this research study because you are between the ages of 18 and 75, are currently enrolled in a Phoenix Health and Fitness program, have had physician clearance to engage in the Phoenix’s supervised exercise program and have been diagnosed with type 2 diabetes or prediabetes. In addition, you will need to pass a cognitive ability test and be able to read and speak English in order to be eligible to participate in this study.

Your participation in this study is entirely voluntary and it is your decision whether or not to take part in this study. Before you decide, it is important for you to understand what this research will involve. This consent form will explain the study, why the research is being done, what you will be asked to do and what will happen to you, and the possible benefits, risks, and discomforts associated with the study. We do not require you to decide today if you would like to participate in the research. Before you decide, you can talk to anyone you feel comfortable with doing so about the research. Please feel free to ask any questions you have whether they be about the research or this consent form. You will be able to ask questions at any time during the research, not just right now.

If you wish to participate you will be asked to sign this form. If you decide to participate in this study you are free to withdraw at any time and without giving any reasons for your decision.

If you do not wish to participate, you do not have to provide any reason for your decision, nor will you face any repercussions.
Please take time to read the following information carefully before you decide. This study is being conducted by UBC researchers. There is no conflict of interest between this agency and the researchers.

**Purpose:**
Regular exercise has many physical and mental benefits, including improved control of blood sugar, or blood glucose levels. This is particularly relevant to people with type 2 diabetes or prediabetes, in which one of the characteristic symptoms is uncontrolled blood glucose. However, many individuals do not exercise enough to attain these benefits. For this reason, we would like to find ways that can lead to overcoming the challenge of exercising on a regular basis. The purpose of this study is to examine self-regulatory skills that lead to increased exercise adherence. The results may be used in future interventions to help people incorporate regular exercise into their schedule.

**Study Procedures:**
Participation in this intervention will involve completion of 9 surveys and attendance at 6 group tutorial sessions. The group tutorials will last ~25 minutes following exercise at 6 separate occasions throughout the 8-week Active Living with Chronic Disease (ALCD) physical activity program (weeks 1, 2, 4, 5, 7, 8). A researcher will lead the tutorial sessions where a variety of health topics will be discussed.

Throughout the 8-week physical activity program we will ask you to complete a survey at 8 separate occasions. These surveys will be completed here at the Phoenix Health and Fitness center.

Four weeks after the last exercise class of the 8-week ALCD program we will again ask you to complete a survey. In order to mail it to you and allow for a follow-up phone call to remind you to complete and send the final survey back to us, we will ask for your address and a phone number at which you’d like us to reach you. This information will be kept strictly confidential, for the purpose of contacting you for data collection at week 12 only, and will not be used for any other purpose.

**Potential Risks:**
There are no known risks associated with the proposed research. You may experience potential inconveniences associated with participating due to the time associated with completing the study questionnaires. Each survey should take approximately 15 minutes to complete and there are a total of 9 surveys across the 12-weeks.

**Potential Benefits:**
There are no known benefits from participation in this study.

If you are interested in learning about the results of this research, please provide a mailing address or email address to which we may send you the study findings:

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
**Confidentiality:**
Your confidentiality will be respected. However, research records and health or other source records identifying you may be inspected in the presence of the Investigator or his or her designate by representatives of Health Canada, and UBC Office of Research Services for the purpose of monitoring the research. No information or records that disclose your identity will be published without your consent, nor will any information or records that disclose your identity be removed or released without your consent unless required by law.

You will be assigned a unique study number as a subject in this study. Only this number will be used on any research-related information collected about you during the course of this study, so that your identity [i.e. your name or any other information that could identify you] as a subject in this study will be kept confidential. Information that contains your identity will remain only with the Principal Investigator and/or designate. The list that matches your name to the unique study number that is used on your research-related information will not be removed or released without your consent unless required by law.

Your rights to privacy are legally protected by federal and provincial laws that require safeguards to insure that your privacy is respected and also give you the right of access to the information about you that has been provided to the sponsor and, if need be, an opportunity to correct any errors in this information. Further details about these laws are available on request to your study doctor.

**Withdrawal:**
You may withdraw from this study at any time without giving reasons.

If you choose to enter the study and then decide to withdraw at a later time, all data collected about you during your enrolment in the study will be retained for analysis. It is a legal requirement that these data cannot be destroyed.

**Remuneration:**
In total, the time commitment for being involved in this study is approximately 5 hours over the course of 12 weeks. In order to defray the costs of inconvenience/transportation/loss of wages you will be reimbursed in the form of cash or gift cards to a local coffee shop (your choice) in the amount of $50. Reimbursement is not dependent on completion of the project. $25 will be given to you at the end of the 8-week exercise program and $25 will be given to you upon return of the follow-up survey you will receive 4-weeks following the end of the exercise program, for a total of $50.

**Contact for information about the study:**
If you have any questions or desire further information with respect to this study, you may contact Dr. Mary Jung at (250) 807-9670.

**Contact for concerns about the rights of research subjects:**
If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services by telephone at 1-877-822-8598 or by email at RSIL@ors.ubc.ca.
**Consent:**

My participation in this study is entirely voluntary and I may refuse to participate or withdraw from the study at any time without jeopardy to my involvement in the Phoenix Health and Fitness programs or access to further services from the community centre.

My participation in this study is entirely voluntary and I may refuse to participate or withdraw from the study at any time without any explanation. If I withdraw from the study my data collected up to the point of withdrawal from the study must be kept for data analysis purposes under strict provisions of confidentiality.

My signature below indicates that I have received a copy of this consent form for my own records.

My signature indicates that I consent to participate in this study.

Signing this consent form in no way limits my legal rights against the sponsor, investigators, or anyone else, and I do not release the study doctors or participating institutions from their legal and professional responsibilities.

<table>
<thead>
<tr>
<th>Subject Signature</th>
<th>Date</th>
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<tr>
<th>Principle Investigator and/or Designate Signature</th>
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<th>Printed Name of the Principle Investigator and/or Designate</th>
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</table>
C.2 Letter of Informed Consent for the Self-monitoring Intervention Condition

THE UNIVERSITY OF BRITISH COLUMBIA

School of Health and Exercise Sciences
Health Sciences Building,
3333 University Way
Okanagan Campus
Kelowna, B.C., Canada V1V 1V7
Tel: (250) 807-9670
Fax: (250) 807-8085

Consent Form
“Increasing exercise behaviour in people living with chronic diseases: A program evaluation.”

Principal Investigator: Dr. Mary Jung, Assistant Professor in the School of Health and Exercise Sciences, Faculty of Health and Social Development. Phone: (250) 807-9670.

Co-Investigator(s): Ms. Kaitlyn Bailey, Master’s student in the School of Health and Exercise Sciences, Faculty of Health and Social Development. Phone: (250) 807-8419.

Emergency Telephone Number: (250) 878-6891

Introduction:
You are being invited to take part in this research study because you are between the ages of 18 and 75, are currently enrolled in a Phoenix Health and Fitness program, have had physician clearance to engage in the Phoenix’s supervised exercise program and have been diagnosed with type 2 diabetes or prediabetes. In addition, you will need to pass a cognitive ability test and be able to read and speak English in order to be eligible to participate in this study.

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There are no known benefits from participation in this study.

If you are interested in learning about the results of this research, please provide a mailing address or email address to which we may send you the study findings:

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___________________________________________________________________________

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You will be assigned a unique study number as a subject in this study. Only this number will be used on any research-related information collected about you during the course of this study, so that your identity [i.e. your name or any other information that could identify you] as a subject in this study will be kept confidential. Information that contains your identity will remain only with the Principal Investigator and/or designate. The list that matches your name to the unique study number that is used on your research-related information will not be removed or released without your consent unless required by law.
Your rights to privacy are legally protected by federal and provincial laws that require safeguards to insure that your privacy is respected and also give you the right of access to the information about you that has been provided to the sponsor and, if need be, an opportunity to correct any errors in this information. Further details about these laws are available on request to your study doctor.

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My signature indicates that I consent to participate in this study.

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____________________________________________________________
Subject Signature                          Date

____________________________________________________________
Printed Name of the Subject                  Date

____________________________________________________________
Principle Investigator and/or Designate Signature  Date

____________________________________________________________
Printed Name of the Principle Investigator and/or Designate  Date
## Appendix D: Summary of Researcher Led Tutorial

<table>
<thead>
<tr>
<th>Class</th>
<th>CON Tutorial Topics</th>
<th>SM Tutorial Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class #2</td>
<td>i. The impact of stress on health</td>
<td>i. what happens inside your body when you have type II diabetes or prediabetes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii. blood glucose: what it is and why it is important</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. instructions regarding how to use a CGM (i.e., when and how to calibrate the device)</td>
</tr>
<tr>
<td>Class #4</td>
<td>i. Abdominal adiposity</td>
<td>Discussion about:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i. participants’ experiences wearing the CGM and self-monitoring</td>
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<tr>
<td></td>
<td></td>
<td>ii. the connection between an acute exercise bout and more controlled blood glucose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. self-monitoring: what it is and why it is important</td>
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<tr>
<td>Class #5</td>
<td></td>
<td>i. Canada’s physical activity guidelines</td>
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<tr>
<td></td>
<td></td>
<td>ii. exercise goals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. self-monitoring of exercise</td>
</tr>
<tr>
<td>Class #8</td>
<td>i. Dietary fiber</td>
<td>Discussion about:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>i. participants’ experience self-monitoring their exercise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii. a reminder about the relationship between exercise and blood glucose control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>iii. participants are asked to try an experiment to see how exercise effects their blood sugar when their diet stays the same</td>
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<tr>
<td>Class #10</td>
<td>i. The importance of sleep</td>
<td>i. looking at participants’ own blood glucose graphs</td>
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<td></td>
<td></td>
<td>ii. learning about action plans</td>
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<tr>
<td>Class #14</td>
<td>i. Mental health</td>
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<tr>
<td>Class #16</td>
<td>i. Flu vaccinations</td>
<td>i. participants reviewed their blood glucose graphs</td>
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<td></td>
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<td>ii. participants made new exercise goals and action plans</td>
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## Appendix E: Summary of Active Living with Chronic Disease Led Tutorials

<table>
<thead>
<tr>
<th>CON Tutorial Topics</th>
<th>SM Tutorial Topics</th>
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<tbody>
<tr>
<td>• Goal setting</td>
<td>• FITT principle of exercise (frequency, intensity, time, type)</td>
</tr>
<tr>
<td>• FITT principle of exercise (frequency, intensity, time, type)</td>
<td>• Chronic diseases and what they are</td>
</tr>
<tr>
<td>• Chronic diseases and what they are,</td>
<td>• Different gaits and foot types and which types of shoes work best for each foot type</td>
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<tr>
<td>• Functional exercise</td>
<td>• Guided mediation</td>
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<tr>
<td>• Macro- and micronutrients</td>
<td>• Fall prevention</td>
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<tr>
<td>• Digestion and absorption</td>
<td>• Stretching</td>
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<tr>
<td>• The transtheoretical model for change</td>
<td>• Energy balance and weight loss</td>
</tr>
<tr>
<td>• Chronic conditions and what they mean with regards to exercise</td>
<td>• Chronic conditions and what they mean with regards to exercise</td>
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<td>• Dietary weight loss tips</td>
<td>• Bone health</td>
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### Appendix F: Measures Timeline

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<tr>
<th>Measure</th>
<th>Pre</th>
<th>Week 2</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 7</th>
<th>Post</th>
<th>Follow-up</th>
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<td>Demographics</td>
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<tr>
<td><strong>PHYSICAL ACTIVITY</strong></td>
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<td>7-day PAR</td>
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<td>Self-regulation Scale</td>
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<td>Self-efficacy</td>
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<td>X</td>
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<td>PAGEQ</td>
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<td>SF-36</td>
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<td><strong>PHYSICAL VARIABLES</strong></td>
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<td>Anthropometrics and resting heart rate</td>
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**Note.** 7-day Physical Activity Recall Questionnaire (7-day PAR) is from Sallis et al. (1985) used to assess moderate to vigorous physical activity; Physical Activity Group Environment Questionnaire (PAGEQ) is from Estabrooks and Carron (2000); and Short Form 36 Health Survey (SF-36) is from Ware & Sherbourne (1992).
Appendix G: Qualitative Interview Scripts

G.1 Qualitative Interview Script for the Standard Care Condition

Call participant on speakerphone from the laboratory phone:

If someone picks up the phone:
Hello, is (name) available? (If the person who answers asks who’s calling, say that you are a student at the University of British Columbia and that (name) said that it would be alright if you called)

If it is the participant:
Hi (name), my name is _______. I am a student at the University of British Columbia. I am in the same laboratory as Kaitlyn, you would have met her at Phoenix Health and Fitness during the exercise classes, she was the one who was doing a study in your classes who you had to fill out surveys for. I am not involved in that study, however, I was hoping to get to ask you a few questions today just to evaluate the program.

Do you have time to answer 4 brief questions right now?

If no: when would I be able to call again at a better time, are you available tomorrow?

If yes: Please answer these questions as honestly as possible, there are no right or wrong answers. We are interested in how to make the program and our studies as effective as possible and your answers to these questions may assist us in improving them.

1. Overall, how do you feel the researcher (Kaitlyn) did in delivering this study?
   • ensure that if participant are just giving positive or just negative comments they know that “we are looking for both positive comments and anything that could have been improved”
   • to prod ask, “is there anything else?”

2. Was there anything that you learned during this 8-week program that really sticks out in your mind?
   • to prod ask, “is there anything else?”

3. Was there anything that you learned during this 8-week program that you have incorporated into your life?
   • to prod ask, “is there anything else?”

4. Is there anything that you wish was discussed more during this program?
   • to prod ask, “is there anything else?”
Ok, thank you so much (name) for taking the time to answer these questions, we really appreciate it! You will be receiving the final survey either in the mail or delivered to you house in about 4 weeks, it is really important that you complete it and return it. Thank you for your time. Bye.

If it goes to an answering machine:
Hello (name), my name is _______. I am a student at the University of British Columbia. I am in the same laboratory as Kaitlyn, you would have met her at Phoenix Health and Fitness during the exercise classes, she was the one who was doing a study in your classes who you had to fill out surveys for. I am calling because during the last exercise session you indicated that you would be willing to answer a few questions for us. There are only 4 brief questions. We will try contacting you again tomorrow, if you know a time that you would be available you can call back and if no one answers you can leave a message with the best times for you to be reached. Our phone number is (250) 807-8419 (SLOWLY).
G.2 Qualitative Interview Script for the Self-monitoring Intervention Condition

Call participant on speakerphone from the laboratory phone:

**If someone picks up the phone:**

Hello, is (name) available? (If the person who answers asks who’s calling, say that you are a student at the University of British Columbia and that (name) said that it would be alright if you called)

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Do you have time to answer some questions right now?

**If no:** when would I be able to call again at a better time, are you available tomorrow?

**If yes:** Please answer these questions as honestly as possible, there are no right or wrong answers. We are interested in how to make the program and our studies as effective as possible and your answers to these questions may assist us in improving them. There are two sections of questions, the first ones are related to the classes and the study overall and the second ones are specifically related to the continuous glucose monitoring devices.

1. **Overall, how do you feel the researcher (Kaitlyn) did in delivering this study?**
   - ensure that if participant are just giving positive or just negative comments they know that “we are looking for both positive comments and anything that could have been improved”
   - to prod ask, “is there anything else?”

2. **Was there anything that you learned during this 8-week program that really sticks out in your mind?**
   - to prod ask, “is there anything else?”

3. **Was there anything that you learned during this 8-week program that you have incorporated into your life?**
   - to prod ask, “is there anything else?”
4. Is there anything that you wish was discussed more during this program?
   - to prod ask, “is there anything else?”

5. What issues, if any, did you have with the continuous glucose monitor (the device you had to wear 3 times for the study)?

6. Did the monitor interfere with any daily activities (i.e., showering, sleeping, moving around, work, shopping)?
   - If yes, how much of an interference?

9. Did you experience any difficulty in understanding the graph on the monitor in order to tell what your blood glucose levels were at?

10. Did you find these graphs had an impact?

11. How did you feel about being able to constantly observe your blood glucose levels?

12. Overall, how east was the device to use?
   - If difficult, what were the difficult components?

13. Would you wear the device again?

14. Do you have any other comments related to the device?

Ok, thank you so much (name) for taking the time to answer these questions, we really appreciate it! You will be receiving the final survey either in the mail or delivered to you house in about 4 weeks, it is really important that you complete it and return it. Thank you for your time. Bye.

If it goes to an answering machine:
Hello (name), my name is _______. I am a student at the University of British Columbia. I am in the same laboratory as Kaitlyn, you would have met her at Phoenix Health and Fitness during the exercise classes, she was the one who was doing a study in your classes who you had to fill out surveys for. I am calling because during the last exercise session you indicated that you would be willing to answer a few questions for us. There are only 4 brief questions. We will try contacting you again tomorrow, if you know a time that you would be available you can call back and if no one answers you can leave a message with the best times for you to be reached. Our phone number is (250) 807-8419 (SLOWLY).
Appendix H: Tutorial Script

H.1 Scripts for Tutorials in the Standard Care Group

TUTORIAL #1:

Impact of stress on health:

• Discuss when people get stressed out, give common examples/categories (can be major life events: changing jobs, worrying about money, or minor everyday occurrences: pressure at work, organizing a community event, public speaking), ask participants to think of a time they were really stressed out? How did it feel? How did it affect their life (may affect your mood, sleeping patterns, what you eat)? –Decades of research has shown that stress has a big impact on health, which I will be talking about today
• In Canada in 2011, daily stress rates were highest in the core working ages, 34-54 and it was at about 30%. People in these age groups are most likely to be managing multiple career and family responsibilities. Also, females have slightly higher stress rates in comparison to males.
• Discuss the evolutionary perspective: A long time ago before there was money to stress about, or work presentations, “stress” meant something very different
• Stress used to be triggered by events such as a caveman running into a bear while hunting, and these are the types of events that humans evolved responses for
• When you experience stress we’ve evolved a response that includes releasing adrenaline, your heart beats faster, you may start breathing more heavily and these types of responses would prepare the “caveman” to deal with the bear, probably by running away. All of these things worked to make sure skeletal muscles and the heart and brain have enough energy and oxygen
• Based on evolutionary perspective, we get these same responses, if you think about that time you were stressed out: did your heart start beating? did you feel adrenaline? what else happened? do you think these responses help in that type of situation?
• Because we adapted to these types of stressors, we still experience these responses as a result of stress, but the reason we are stressed is very different. If you’re about to give a presentation and you are feeling stressed, you may experience adrenaline and an increased heart rate and an increase in breathing. But when we are stressed about these things having your heart pump a lot harder doesn’t really help you to get past the immediate danger and therefore doesn’t really help. Humans may still occasionally encounter a situation in which they require the evolved stress response but for the most part, for the reasons we are stressed these responses don’t help us.
• Even worse though than the fact that these responses no longer help us is that they can cause harm. These responses were developed to combat a short “intense” period of stress, like the example I used, encountering a bear in the forest. But now a days people often experience chronic stress. They will feel stressed out for really long periods of time, or they will experience short periods of stress really often.
• This is bad because although these responses may be beneficial in short spurts when it isn’t very often, if they are always “turned on” this can cause serious health damage
• Chronic levels of stress have been shown to lead to or promote cardiovascular disease, depression and it can cause a decrease in the immune system which results in an
increased risk of contracting viruses and infections such as the common cold, HIV/AIDS, and herpes, and for people with diabetes, chronic stress can make it more difficult to control blood sugar levels.

- I’m a graduate student right now but during my undergraduate degree I helped out in a laboratory that looked at how stress can impact cardiovascular function. So we would stress people out and then we would look at changes in the health of their blood vessels.
- Stress can also result in changes in behaviour, which can be detrimental to health such as alcohol abuse and weight loss or weight gain.
- What should you do to try to decrease your stress:
  - The first step is to understand what situations cause you to become stressed – one way to help you understand what makes you stressed is to keep track of it in a book. For one week keep track of everything that makes you stressed, this may be a major event that is about to occur, long time worries, or even daily annoyances/hassles.
  - After this week look back and try to find ways that you may be able to cope with that stress – think back to all of the times you were stressed the past week and identify what exactly caused that stress, it may be deeper than you first thought. Once you know what it is, work on solutions so that it won’t stress you out. If you get stressed out during traffic jams, maybe tell yourself that every time you get into a traffic jam, instead of getting stressed out you are going to take 3 deep breaths. Sometimes stress is caused by something someone else does and you can’t change that but you can change whether you put yourself in that situation or you can change how you deal with it. You may not be ready to make a major change if that’s what it would take to decrease your stress, but it’s still really important to be aware of why you are feeling stressed out.
  - Talk about how you are feeling with family or friends – by talking about it you may feel like you are no longer “in it on your own” and they may be able to help come up with solutions as to how to deal with the stress you’re feeling.
  - Sometimes you may need to reduce tension, take deep breaths
  - Let’s try a breathing exercise right now:

Close your eyes. Try to get as comfortable as you can in your chair. Focus on your breath and rhythm of breathing. See if you can hear your breath. If you are breathing quickly try to slow down you breath. Count to 4 as you breath in. 1-2-3-4. Count to 8 as you breath out. 1-2-3-4-5-6-7-8. Try to take deep breaths. Imagine that your lungs are divided into three sections. On your next breath focus on just filling the lowest section of your lungs with air. Do this by pushing your diaphragm down and forcing your stomach out. Now, on your next breath first fill that lowest section then fill the middle section of your lungs with air by expanding your chest and raising your rib cage. Lastly, on your next breath fill the lowest section, then the middle section, and lastly the highest section. To fill this last section you will feel you chest and shoulders raise a bit. Hold this breath for a couple seconds and then exhale slowly by pulling your abdomen back in and lowering your shoulders and chest. Try two more breaths starting by filling the lowest section of your breath, moving to the middle section and finally the highest section... If you are ready you can open your eyes again.

- To take your mind of the problems that are “long time worries” it may help to do an activity that you really enjoy, such as reading a book, or take up a new hobby or class,
because then during that time you are thinking about something else. For example, this class, or I just started a pottery class downtown.

• Lastly, some tips on how to prevent stress in the future:
  • Make decisions. Worrying about a decision causes stress.
  • Avoid putting things off. Organize your time well and plan out when you are going to get your work done.
  • Make a list of everything you need to do or things you are worried about so you don’t have to think about them anymore. My Dad loves to make lists; I used to get a “To Do List” every Saturday morning.
  • Think positively; don’t be too hard on yourself. And be realistic with what you want to accomplish.
  • Pick one of these tips and try to do it tomorrow for the whole day.
TUTORIAL #2:

Abdominal Adiposity:

- There are many different body shapes, sometimes we classify people as apple and pear shaped.
- Apple is when you store most of your fat around your stomach region –apples are more top heavy.
- Pear is when you store most of your fat a bit lower, in your hips and bottom –pears are more bottom heavy.
- This “apple” shape, or, when you store your fat in your stomach region is more dangerous than the “pear” shape because it is associated with greater health risks.
- This is because it is usually indicative of a different type of fat: there are two types i) visceral fat and ii) subcutaneous fat.
- Some fat on the body is very necessary as it protects you if you fall and can be used as energy storage and can keep you warm. People evolved to be able to store fat for these reasons.
- Subcutaneous fat is fat that is stored just below the skin, when you feel it, it is soft and squishy because it is right below your skin. This is the type of fat babies have when they are born. For pear people, so people who store their fat in their hips and butt, this is usually the type of fat that is stored, some of this type of fat is good and healthy, too much can still be a health concern but this type of fat is much less of a risk to health.
- The other type of fat, visceral fat, is fat that is stored between organs, so much deeper than just below your skin, often in the abdominal region, this type of fat is not soft to the touch but much harder and isn’t squishy, this is because it is all packed in between the organs so it is pressing out on your stomach muscles, apple shaped people are more likely to have this type of fat because it is fat that is found in your abdomen and chest, the places where apple shaped people store their fat.
- This type of fat is much more of a health risk.
- It is possible and likely that in your abdomen you have both subcutaneous and visceral fat, so some of that which is stored between your organs and some just below the skin.
- Next you may wonder how can you tell how much of each type you have?
- Waist circumference is one way to get an estimate to measure where the fat is located and to infer from that what type of fat it is. This is because, as I was saying before, visceral fat is generally located in the abdominal region, so if you have a larger waist circumference than it is more likely to be visceral fat, than subcutaneous. It’s not a perfect measurement, because as I said before you can also have that “squishy” subcutaneous fat in the abdominal region too.
- Waist circumference gives us an idea though about where fat is located. Have you heard of BMI, it looks at how much you weigh in comparison to your height and gives you an idea of whether you should weigh more or less, but BMI doesn’t tell you anything about where that fat is located on your body or what type of fat that is and this is very important because as I said before, one type of fat is more of a health risk than the other.
- The best way to measure in an inexpensive manner than is to combine multiple techniques. So BMI and waist circumference. Therefore you get a better picture of how much weight and also where it is located.
• You may now wonder, why do some people store fat in their stomach region and others
don’t—it has to do with many things, unfortunately most of them you can’t help because
you were just born that way
• 1) **Hormones: estrogen** tends to result in fat being stored in areas other than the stomach.
   Because of this, it is more likely that women are the pear shape and men are the apple
   shape. So girls you are lucky because estrogen seems to protect us a bit from storing fat
   in the stomach region. This isn’t always true though, just more often. As well, once
   women hit menopause estrogen levels decrease and then women have a tendency to start
   storing fat around their middle more. So because of different hormones gender tends to
   play a role.
• 2) **Hormones: cortisol**, something I talked about last week, is a hormone that is often
   released in response to stress. So if you are stressed out cortisol is in your body at much
   higher levels and cortisol tends to lead you to storing fat in the abdominal region.
• 3) **Genetics**. Like all other things you can blame your parents for this one. There are a
   few genes that have a huge impact on where you store your fat; so just because of
   genetics you may be more likely to store your fat in the abdominal region.
• 4) Some **prescription drugs** can affect where you store fat.
• One last topic I wanted to discuss is whether or not different foods lead to fat being
   stored in different areas of the body. The short and sweet answer is no. The type of food
   you eat does not effect where you are going to store it in the body as fat. All that it
   depends on is whether you are in excess of calories, so if you are eating more calories
   than you are burning off in a day and then this will result in some of those calories being
   stored as fat and where you store them will depend on the things that I just talked about,
   so what hormones are in your body, possibly some medications and genetics.
• Any other questions?
TUTORIAL #3:

Fiber:

- I want to start by hearing what you guys have heard about fiber? Do you think that it is good for you? Why? What would you eat for breakfast if you wanted to get lots of fiber?
- Talk about common breakfast foods, how much fiber is found in each of them. Guesses first: apple cut up into 1/3 cup of Quaker Large Flake oatmeal (6 grams), 1 cup of Kellogg’s Raisin Bran (6 grams), 1 bowl of Fiber 1 (13 grams)
- Show on nutrition label where it tells you how much fiber is in each food – under carbohydrate it will divide into sugar and fiber
- What is fiber? It’s the part of the plant that humans cannot digest. So in a plant, like an apple, there are many components and some of them the body can use and absorb to turn into energy, like the sugars. But fiber just goes straight through, we cannot digest it and we do not get any energy from it. There are lots of bacteria though in your large intestine, good bacteria that are healthy to have, and these bacteria can break down the fiber and then your colon can use the energy from it (this is very small though). No meats or dairy contain fiber. Just plants, so fruits, vegetables, grains and legumes.
- Have you ever heard of two different types of fiber? Two main types that people talk about when they are referring to food – soluble and insoluble, they are divided because they are different chemically and physically and therefore they do different things for us
- **Soluble Fiber**: Dissolve in water, that’s why they are called “soluble fibers”. These form gels and are often gummy. These are the ones that are easily digested by bacteria in the colon (large intestine). In foods, these add a consistency that we usually like, like pectin in jam, it gives it that jelly feel. And they can be added to salad dressings or other foods to thicken them.
- Some common examples of foods that are higher in soluble fiber include: oats, oat bran, rye, fruit (apples, citrus), legumes (especially young green peas and black-eyed peas), seaweeds, seeds and husks, vegetables
- **Insoluble Fiber**: Don’t dissolve in water and they also don’t form gels like soluble fibers do. These fibers are more what you’d think when you hear the word fiber. They are the outer layers of grains, the strings in celery, the hull or shell of seeds and skins of corn kernels. Even when they are cooked for hours they often keep their structure and their rough texture.
- Some common examples of foods that are higher in insoluble fiber include: brown rice, fruit, legumes, seeds, vegetables (cabbage, carrots, Brussels sprouts) wheat bran, whole grains
- We can separate them but most plants have both, at least some of each, therefore in recommendations they don’t separate them, they just talk about total fiber
- Why do you often hear that fiber is good for you?
  - 1) It can help keep your cholesterol levels more normal – this is because these fibers can attach themselves to the cholesterol in the intestine, and then since the fiber isn’t digested itself both things just pass through. It is the jelly-like soluble fiber that does this.
  - 2) It can help control blood glucose – the jell-like fibers again can sometimes trap nutrients and slow down the time it takes before they are absorbed. This helps so that you don’t get those high spikes in blood sugar, which are thought to be associated with the onset of diabetes. Since there is less of a sugar spike less insulin will be released too.
3) And probably the one you hear about most – fiber keeps you regular (prevents constipation). Makes stools heavier and increases the speed of passing. This is the fiber that is more structured, outer layers of grains and seeds and lots of vegetables, strings in celery. This requires water too. If you are eating lots of fiber you need to drink lots of water. Keeps your colon healthy! Some research says lots of fiber may help prevent colon cancer.

How much should you be eating?

Recommendations for fiber:

Average intake is about 14-15 grams, very low!

World Health Organization: More than 25 g of fiber from whole grains, fruit and vegetables

Canada’s Food Guide: Have vegetables and fruit more often than juice (compare fiber in an apple versus apple juice (5x as much fiber in an apple), make at least half of your grain products whole grains each day, and have meat alternatives such as beans and lentils often (instead of animal meat and cheese to get protein)

Dietary Reference Intakes (DRI): Adequate intake is 38 g of total fiber per day for men through age 50; 30 g for men 51 and older

Adequate intake is 25 g of total fiber per day for women through age 50; 21 g for women 51 and older

Good to have variety and not just eat tons of one food that is high in fiber

Bread: Whole-grain (whole wheat) vs. Enriched white vs. White bread – Enriched white and white bread only have about ¼ of the fiber that whole-grain bread has

Too much fiber? Too much fiber (e.g. from wheat bran) or too little fluid can overwhelm the digestive system. Fiber carries water out of the body and can lead to dehydration so make sure you drink enough fluids

Some people have concerns that purified fiber might displace nutrients from the diet or cause them to be lost because they bind, but they don’t

A purified fiber may not affect the body the same way as the fiber in its original food product, most experts agree that the health benefits attributed to a fiber may come from other constitutes of fiber-containing foods and not from the fiber alone
TUTORIAL #4:

Importance of Sleep:

- How many hours of sleep do you usually get on average? Is it very consistent (same number of hours most nights? go to bed and wake up at the same time?)
- I’ve read that getting the right amount of sleep is one of the most important things you can do to prevent disease and stay healthy. And I said the right amount, not “enough” sleep because too much sleep may cause problems too
- Reasons to get enough sleep
  - **Learning and memory**: Sleep helps the brain commit new information to memory through a process called memory consolidation. In studies, people who’d slept after learning a task did better on tests later.
  - **Safety**: Sleep debt contributes to a greater tendency to fall asleep during the daytime. These lapses may cause falls and mistakes such as medical errors, air traffic mishaps, and road accidents.
  - **Mood**: Sleep loss may result in irritability, impatience, inability to concentrate, and moodiness. Too little sleep can also leave you too tired to do the things you like to do.
  - **Immune system**: Sleep deprivation alters immune function, including the activity of the body’s killer cells. Keeping up with sleep may also help fight cancer.
  - **Blood Sugar**: not enough sleep results in higher than normal blood sugar levels
- How much sleep do you need? People who live longest slept 6.5 to 7.5 hours. The ideal amount of sleep associated with different diseases was different for many. This is really up to you though! Depends on age, how active you are, pregnant women often need more sleep. So overtime it may not stay the same. We don’t seem to be able to “adapt” to getting not enough sleep. Some people just get used to feeling sleep deprived. For many years researchers said that if you don’t get enough sleep one night, you cannot make up for it by sleeping more the next night.
- How to fall asleep more easily
  - Try not to look at bright artificial lights (i.e. TV, computer) –tricks your brain into thinking that it is still daytime
  - Stop doing work 1 hour before bed
  - Don’t drink caffeine
  - Hot bath
  - If you do other things in bed (work) it can prevent you from sleeping. If all you do is sleep then your body knows, now it’s time to sleep
  - Get into a regular routine, go to bed at similar time and then wake up at a similar time. Early to bed, early to rise.
  - Listen to soothing music, or white noise –you can train your body to associate certain things with sleeping, like when I hear this calming music I should be sleeping
  - Our bodies really like routines

Some diseases that may result in interrupted sleep:

- **Insomnia**: women more often than men, about 1 in 3 people have some symptoms of insomnia; 3 main symptoms are 1) difficulty in initiating sleep, 2) disrupted sleep and 3) early morning awakenings; it can have quite a large impact on quality of life. It often
becomes a cycle, you are awake so you are worrying because you think you need to sleep and then because you are worrying you can’t sleep. They say you shouldn’t lie in bed awake.

- **Sleep apnea:** obstructive sleep apnea is the most common and it is when the upper airway collapses and you stop breathing, then your body kicks in and often you take a large quick breath. Often times this is when the person wakes up. So they get very interrupted sleep. Also, having sleep apnea puts you at risk of cardiovascular disease. The other form of sleep apnea there isn’t a block but the person stops breathing.
TUTORIAL #5:

Mental Health:

- Generally in this class we have covered many topics regarding physical health but today I’m going to speak about mental health
- Mental and physical health are closely interconnected
- Physical illness and mental illness often occur together, the state of a person’s mental health can influence the onset or course of a physical or mental illness, similarly, the state of a person’s physical health can influence their mental health
- It is so important to have skills to enhance your mental well-being because if you don’t it can impact every area of your life
- Mental health isn’t just the absence of mental illness – I’m sure you guys have heard of many mental illnesses: depression, anxiety, attention deficit disorder, eating disorders; but being mentally well, beyond just not having a mental illness, can help you to reach your full potential
- Some of the topics that I’ve discussed earlier have a big impact on mental health such as sleep and stress
- Balancing your life: mental health means striking a balance in all aspects of your life – **social, physical, spiritual, economic and mental**. Reaching a balance is a learning process. At times you may tip the balance too much in one direction and have to find your footing again. Your personal balance will be unique, and your challenge will be to stay mentally healthy by keeping that balance
- How to find and keep your balance:
  1. **Build healthy self-esteem**: Self-esteem is more than just seeing your good qualities. It is about seeing your abilities and weaknesses together, accepting them and doing your best with what you have. For example, even though you don’t write well enough to get your books published, this shouldn’t defer you from writing if that’s what you love to do.
  2. Along with self-esteem is **self-confidence**: Make a list. Take a look at your good points. What do you do best? Where are your skills and interest areas? How would you describe yourself? Now look at your weak points. What do you have difficulty doing? What things make you feel frustrated? Look at this list. Remember that EVERYONE has positive and negative sides. We let our strengths shine, and we build on our weak points to help us mature and grow.
  3. **Receive and give compliments**: Many of us confuse having a realistic view of our good points with conceit. We have trouble accepting kindness from others. We often shrug off a compliment with “Yes, but…” and put ourselves down. ACCEPT compliments and say “Thank you”. Think about other compliments you have had and how good they make you feel.
  4. **Find relationships that count**: It’s important to have a people who you can trust and who you can count on to help share both your joys and successes in life as well as troubles or challenges you may run into. I just moved to Kelowna in September and when I moved I didn’t know a single person living here but I went to some community events and volunteered for some charities in town and I met people who I have become good friends with. I now it’s really not always easy to make friends but it can really make life easier to be able to count on other people
5. **Figure out your priorities:** I’d say this is one of the hardest, especially in terms of money. Lots of advertisers try very hard to convince us that we “need” their products. The big challenge is to figure out what you need versus what you want.

6. **Get involved:** Being involved in things that really matter to us provide a great feeling of purpose and satisfaction. You should always remember that you make a difference, no matter how big or small your efforts.

7. **Learning to deal with stress:** I know I talked a lot about this one in the first week but it’s about sharing your problems with other people, staying positive, breathing exercises, making lists helps me.

8. **Spend some quality time with yourself:** Learn to be at peace with yourself. Get to know who you are: what makes you really happy, what you are really passionate about. Learn to balance what you are able to change about yourself with what you cannot change.

9. **Most important, try to find things you really enjoy in life!**

   - I for example really love reading novels, I love getting lost in the stories and just spending an hour reading with a cup of tea, but I’m a student so I always have other things that I feel like I “should” be reading instead and so I haven’t read many novels at all over the past few years. But while thinking about mental health this week I decided to start a new novel and I found it completely energized me and I actually was probably more productive when I went back to schoolwork because I was feeling good.

   - I’m giving you homework, this next week do one thing that you really love doing and see how happy it makes you and whether that affects any other aspect of your life.
TUTORIAL #6:

Flu Vaccinations:
I am just going to start by asking a couple questions.

- Can anyone tell me one thing they heard or know about influenza or the flu?
  - The flu is very common
  - It is an infectious respiratory disease
  - It originates in your nose and throat

- Does anyone know how influenza or the flu spreads and if it is highly contagious or not?
  - Highly contagious
  - Spreads rapidly from person to person
  - Influenza typically starts with:
    - Headache
    - Chills and cough
    - Followed rapidly by fever
    - Loss of appetite
    - Muscle aches and fatigue
    - Running nose, sneezing
    - Watery eyes
    - Throat irritation
    - Nausea, vomiting and diarrhea may also occur, especially in children.

- Just to see a quick show of hands, who got their flu shot this year?
  - All Canadians over age of six months need to get a flu shot
  - Did you know that the flu shot is the BEST way to protect yourself and others from the virus?

- When is the best time to get your influenza vaccine?
  - EARLY: between October and December
  - This is because you would want to maximize your health by getting the shot early so that your body is immune before these influenza cases increase in Canada.
  - Some of you may be thinking is it beneficial if it is past December to get your flu shot?
  - YES, still effective if you decide to get the flu shot later in the season.

- It is important to note that the flu shot is not effective right away. Once you get the immunization it will take two full weeks until your body will have full protection from the flu shot.
  - It lasts for 6 months from when you got your flu shot that year.

- Do you think the flu shot prevents you from getting the flu in the near future?
  - Every year there is a new vaccine to protect people against new strains of this influenza virus

- Who do you think are considered most vulnerable to the flu?
  - Very young
  - The elderly
  - Weakened immune system.

Highly important to get vaccinated if you are part of the high risk group, which include:

- 65 years and over
- Health care workers such as doctors or nurses
- All children aged 6-59 months
• Healthy pregnant women
• People with certain chronic health conditions such as:
  • Heart or lung problems
  • Diabetes
  • Cancer
  • Weakened immune systems
  • Kidney disease
  • Severe obesity
  • Anemia
• People who live in nursing homes or other chronic care facilities
• Aboriginal people

You as an individual could potentially transmit influenza to those in high risk groups because:
→ You live or work with them (e.g. household contacts, daycare workers)
→ You provide essential community services
→ You are more likely to be in contact with those in the high risk groups.

Interesting Facts:
• Yes, people can recover from the flu as many of you have recovered but it is important to note that the results show from the Public Health Agency website that between 2,000-8,000 Canadians die from the flu and over 20,000 are hospitalized

If you are wondering how the flu shot gets produced and why you should get it every year here is a quick explanation:
• Influenza virus, commonly known as the flu, is spread easily and is constantly changing to be able to beat your immune defenses.
• Viruses have the ability to change and each year we see a unique type of the influenza virus emerge. These are called strains.
• The world health organization is responsible for creating a vaccine that will protect you and I from the strains of flu virus that they believe will be most prevalent during the upcoming flu season.
• The flu shot is a combination of three strains that will provide you with the ability to fight infection associated with the three most important strains and will help keep you from getting the flu that year.

How to Prevent the Flu during Flu Season?
1. Get your flu shot
   -EVERY YEAR
   -Most effective to prevent catching the spread of the flu virus
2. Find a flu shot clinic
   -Going online for local health clinics that are offering flu shots or even local flu shot clinics
3. Wash your hands
   -Bacteria and viruses can be removed easily by simply washing your hands frequently with soap and water for at least 20 seconds
   -By washing your hands and not touching your face can help prevent the spread of germs. This is beneficial because the flu virus enters the body through the eyes, nose or mouth like I said earlier
   -Wash hands thoroughly or you can even use alcohol-based hand sanitizer
-These alcohol-based hand sanitizers are effective in killing viruses.

4. Practice cough etiquette
   -Such as cough and sneeze into your arm and not your hand. This will prevent the spread of germs from person to person interaction.

5. Keep common surface areas clean and disinfected
   -Steering wheels, doorknobs, light switches, telephones, keyboards are just a few examples for contamination to occur with bacteria and viruses.
   -Just by regular cleaning and using disinfected wipes can help stop the spread of these germs.

DID YOU KNOW:
How long do you think viruses can live on hard surfaces for?
- Viruses can live on hard surfaces for up to 48 hours.

6. If you get sick, stay home
   - If you think you have the flu, you should stay home from school or work until your symptoms are gone. If your symptoms get worse, call your health care provider.

7. Most important: Keep your immune system strong by eating well.
H.2 Scripts for Tutorials in the Self-monitoring Intervention Group

TUTORIAL #1

Hi I’m Kaitlyn, and I am a graduate student at the university in the Health and Exercise Science department. Today I am going to talk about three main things i) diabetes and ii) blood sugar and iii) the continuous glucose monitoring devices that we will be giving you after class today. I welcome you to ask questions throughout as they come up!

For everyone who is involved in my study: To be eligible you must have been at risk of getting prediabetes based on other chronic diseases you have, have prediabetes or have type 2 diabetes (T2D). Prediabetes means that although you don’t currently have diabetes, your blood sugar levels are consistently high and this means that you are at higher risk of getting diabetes in the future, especially if you don’t change your current lifestyle. If you have been diagnosed with T2D your doctor has likely talked to you about blood sugar before. For all of you, knowing what your blood sugar levels are is important and I hope you will understand why by the end of this chat.

Many people have heard about T2D. If you have it your doctor may have talked to you about medications or insulin. However, you may not know what is actually going on inside your body. So that is where I’m going to start.

Diabetes

Let’s go back even farther than diabetes and first just talk about what happens to the food you eat if you don’t have diabetes. Every time that you eat something that food goes through your mouth and into your stomach and intestines. The food gets broken down into fats, proteins and sugars. I’m going to talk just about those sugars. You may have heard the term “glucose”, that’s really just a fancy word for sugar so I’m just going to call it sugar. Once the food has been broken down into sugars, the body then absorbs them and they enter the blood stream. When I say they enter the blood stream, what I mean is that there are blood vessels that go everywhere in your body and they are all connected so wherever that sugar may have been absorbed, once it’s in your blood stream it can travel anywhere in your body.

Everyone think about what parts of the body might need sugar? Anyone come up with one? Muscles, the brain, fat tissue…

Right! So the sugar is in your blood stream because it needs to be delivered to all of those important areas that require sugar or that can store the sugar for later.

The blood stream is kind of like a large web of highways and the sugar molecules are cars on that highway traveling to all the cells in the body that may need sugar (e.g. muscle cells and brain cells). The problem is that the “sugar cars” can’t get off the highway, or out of the blood stream. They are stuck on this highway and just keep traveling. That is where a molecule called insulin comes into play. Who here has heard of the word insulin before, raise your hand. Good, so most of you/all of you. Let’s imagine that insulin is like the off-ramp/exit ramp. We need insulin so that the sugar cars can get off the highway, or out of the blood stream, and into the cells that need them for fuel or storage. The human body is very intelligent and when you eat food insulin is automatically released into your blood stream in anticipation for the sugar that is about to be circling around. Insulin allows sugar to get out of the blood stream and into the cells.

To recap: You eat a banana, that banana is broken down into ______(sugars), those sugars are absorbed into the ______(blood stream), your body adds some ______(insulin) to the blood and then the sugar is able to leave the blood stream and enter muscle cells, or whatever other cells
need it. So that is what happens when an individual without diabetes eats food. What then is diabetes you may ask?
The problem for people with T2D has to do with insulin. People with T2D still have the same amount of insulin in their blood stream after they eat something. The problem is it is no longer doing its job. It is there but it is no longer acting as an off-ramp/exit ramp for those sugar molecules. The sugar molecules then become stuck in the blood stream and they can’t get to the cells that need them. That is why diabetes is characterized as high blood sugar levels, because the sugar can’t get out of the blood.

Today you are going to get to wear a continuous glucose monitor. Like I was saying on the first day, never before have we been able to get an inside picture of exactly what is happening to blood sugar levels as it happens. The closest we’ve been able to come in the past is finger pricks but with the finger pricks you don’t get to see the peaks and drops in blood sugar and like I was saying, it’s the pattern of peaks and drops and this really uncontrolled blood sugar that is detrimental to health. Finger pricks can’t show you how well your blood glucose is controlled or regulated. You are going to get the unique opportunity to see the effects of different food and exercise on your blood sugar patterns and to see the pattern of blood sugar across the day by wearing this continuous glucose monitor. As I explained on Tuesday, what this device is, is a very small tube, about 1-inch long and the diameter of a piece of fishing line. It is going to be inserted into your stomach and is going to be measuring your blood sugar level. It will then send that information to a cell-phone or pager sized screen on this monitor (hold it up) so that you can see a graph of your blood sugar. Some people take finger pricks to test their blood sugar level but with a finger prick you only get to see certain time points throughout the day and this device lets you see what your blood sugar across the entire day! It is a very cool device and really gives you a good picture of your blood sugar patterns. Like I mentioned before they cost about $800 so it really is such an awesome chance to get to wear it without the costs. Since the CGM is inserted into your stomach it is not measuring blood sugar directly from your blood stream. Therefore it uses an equation to determine what your blood sugar is. And for this to be accurate it needs to be calibrated. It is VERY important that 2 times a day you take a fingerprick and calibrate the CGM. Right when you wake up and then lastly right before you go to bed. I’m going to go through with you right after this exactly what you need to do in order to do a calibration and I welcome lots of questions but if you are still unsure of anything please ask when you are being fitted with the continuous glucose monitor. Since we will be asking you to do a finger prick 2 times a day, right when you wake up and then right before you go to bed, a suggestion that I have for you is to put the finger prick kit somewhere you will see it right when you wake-up and right before you go to bed such as in the bathroom or beside your bed.

I am going to now hand you out a logbook. This logbook is going to be VERY important over the next 8-weeks so please put it somewhere that you will remember to always bring it to Phoenix, and this week you will be writing lots in it so you will need to keep it very handy. This logbook also has all of the instructions in it that I am explaining to you now so it is very important that you don’t lose it. If you go through, you will see that on the first page is

- Contact information (lab vs cell phone)

Then as you flip through you will come to the first section, September 19th 2013. The first page explains:

- Everything you need to know about CGMs (go through each bullet point individually)
- Page about calibration
I will now show you how to use a fingerprick for those of you who have not used one before. When you are being fitted with the continuous glucose monitor we are going to get you each to practice going through one each.

Firstly you will need to clean the finger that you are going to prick with soap and warm water. Next, pull back this button on the pin to prepare it. Then push the end of the pin against your finger and press the button. In the other device you will now need to insert one of these tiny strips with the black and white striped end facing up and out so you can see it, and it will turn on. When it is ready and the screen looks like this, put the end of the strip with the black and white stripes to the drop of blood and you will see the strip suck up the blood, and then wait for it to tell you your blood sugar.

After you prick your finger write this blood sugar number down in your logbook and also enter it onto the CGM monitor. The exact details about how to enter it into the monitor are on the same page as the details about how to take a finger prick.

- Go through calendar explaining exactly when they will need to take readings and examples
- You will take 2 recordings, one in the morning and one in the evening, and these are the ones that you will enter into this monitor and write in your logbook, I added 2 other times as well though that I would like you to look at the monitor and record what your blood sugar level is in your logbook.

I will also ask you to record what you eat. As I said before what you eat has a large effect of your blood sugar so here in your logbook I will be asking you to write down exactly what you eat and drink for the next 5 days.

- Go through food calendar explaining that they need to write in EVERYTHING that they eat or drink and the time and give examples of a day

When you are wearing this device if you have ANY questions over the next week my cell phone number is here in the logbook (show cell phone number on front again) and feel free to call me if you have questions or concerns. We have also listed our lab phone number here in the logbook so if you call there someone will also be able to help you. The lab is where I work and all of the ladies there are aware of my study and research so they will be able to help, however, there will not be people there after hours so definitely call my cell phone if you have issues later in the evening. My cell phone number here is like your 24-hour help line.

Ok. So it is very exciting that each one of you is going to be able to get an in depth look at your blood sugar.

I want you, over the next week to really pay attention to what your blood sugar levels are and, don’t necessarily do anything to change them, but do everything you regularly would while monitoring how your blood sugar changes in response to that.

Ok does anyone have any questions? It is likely that if you have a question there are other people with the same question so I encourage you to ask now but if you don’t want to then please ask while you are being fitted with your CGM.

Now I am going to hand out a survey for you to complete and while people are completing it I am going to take people aside to get their CGM.

Over here is Dr. Jon Little. Dr. Little is an exercise physiologist, and his primary research looks at the blood glucose response to exercise in people with diabetes. He uses continuous glucose monitors in all of his research. Dr, Little and I will be the ones giving you the continuous glucose monitors today. Dr. Jon Little and I have both had extensive training in how to administer them so please ask us any questions that you may have about them.
Hi guys! So you wore your continuous glucose monitor for a week! Did you all bring your new logbooks back? I think we should start off by having a bit of a chat about how things went.

- **How was writing down your blood sugar levels in your logbook?** Did you find it difficult to remember to do it? Did you always remember to check your blood sugar levels at the necessary time points? Did you write it in your logbook right after you took the blood sugar reading? You’re all in the same boat so any tips you have it would be great to share with each other! [Depending on what they say emphasize the importance of trying to complete the logbook directly after checking the value because that’s the most surefire way to make absolute sure you will remember to do it, often when you say you’re going to remember to do it later you end up forgetting] Where did you keep your logbook to make sure you always remembered to have it with you? Did you check it at any additional time points?

- **Did you notice any changes in your blood sugar depending on what you were eating?** What happened after you ate a meal? Were blood sugar levels fairly consistent from day-to-day? Was what you were eating similar from day-to-day?

- **Did you notice that you felt different depending on what your blood sugar level was?** Were there any patterns? Did you feel tired, energetic, hungry? Sometimes people experience what they describe as a ‘fog’ when their blood sugar levels are high. I really wanted you to be monitoring your blood sugar levels so that you can see how they affect all of these things and you can make better sense of why you might feel they way that you do and how blood sugar affects how you feel.

So what you all did this past week was learn a very important skill, the skill of self-monitoring! Self-monitoring is basically just observing your behaviour and what happens as a result of that behaviour. So for the past week you all self-monitored your eating behaviour and also changes in your blood sugar levels and mood! Wow that is awesome, you learned how to self-monitor and you didn’t even know you were doing it! I asked you to record your blood sugar levels so that you can look back now and visually see differences on how the things you do in your life affect your blood sugar levels, such as what you eat, or if you are feeling stressed. I am going to be giving you graphs and I want you to look through your logbook and try to make sense of the graphs, but we’ll get to that. It may seem simple to just write down your blood sugar level and what you ate and how you were feeling, but it is these really simple skills that can lead to bigger changes. Lots of research has shown that the simple act of self-monitoring, or writing down things like blood sugar levels or what you eat, leads to people being more successful at making a change in the behaviour they’re monitoring. So this goes for ANY behaviour, if you start monitoring your smoking that can help people to quit smoking, if you start monitoring your exercise it has been proven to help people reach their exercise goals. That is why I am getting you all to self-monitor because it is a very useful skill to learn when you are trying to make a change. And quite often it’s not actually as simple as it seems, as we saw when we were chatting in the group it’s easy to forget to write it down. Just like any skill it is something that needs to be practiced. It will take time and motivation to complete the logbook before it becomes routine. It’s really important that you guys all take advantage of the practice that I will be providing you
over the next couple of weeks. I will be asking you to practice, practice, practice and if you do, by the end it won’t seem like a hassle anymore.

One really cool thing that we didn’t talk about when we were chatting at the start is how exercise impacts blood sugar levels. Last week I had you all write down what you ate and how you felt but we didn’t write down anything about our exercise. Did anybody notice any changes in blood sugar when they were exercising? How about after they exercised? **One single bout of exercise is able to better control your blood sugar levels for up to 24 hours!** That is amazing. After just exercising one time your blood sugar levels will be more controlled, you won’t see those peaks and lows that I spoke about last time. This is so important because it is those blood sugar peaks that can cause a lot of damage to your body. I brought in an example of what your blood sugar graph will look like when you compare a day that you didn’t exercise to a day that you did exercise. So the person who was wearing the continuous glucose monitor was a prediabetic and we had him eat the exact same food two days in a row so that the changes in blood sugar weren’t due to eating different foods. Blood sugar is shown along the y-axis here and time of day is shown along the x-axis here. Each of these red dots along the bottom represents a meal. So here is breakfast, and then just like you all experienced, after breakfast blood sugar increased. And here is lunch, and again after eating lunch blood sugar went up. And finally the last dot is dinner and again, after eating dinner blood sugar went up. The really cool thing is that on one day we had him exercise and on the other day we asked him to not exercise. And look what happened! You can see right here, this line is from the day that he didn’t exercise, see how much higher his blood sugar goes up after each meal? This, however, might not happen if you just started exercising, it may take a couple weeks before you start seeing things. I just wanted to point out again, how if you only took a finger prick at these two time points you might think that your blood sugar was doing quite well but look at all of this information that you would be missing! Now that you all have worn the monitors for 5 days I have downloaded all of the information so we can look at your graphs and see what happened inside your body, to your blood sugar levels, when you exercised. It is going to be a bit more confusing with your graphs because I didn’t get you to eat the same thing everyday at the same time. And although exercise can help your blood sugar levels, it can’t compensate for what you eat. So if one day you eat lots of treats, your blood sugar is going to increase, regardless of whether you exercised or not. That exercise is still helping though! And your blood sugar is still not increasing as much as it would if you didn’t exercise, you just can’t tell because you have nothing to compare it against. **Explain to everyone how graphs are displayed.** I want you all to look at your graph and look at your logbook and try to see patterns, when you ate X what happened to your blood sugar. When you were feeling X where was your blood sugar? Etc, and I will come around and answer any questions you might have too! You might get to see peaks and lows. It is common that your “peak” or the highest point of your blood sugar increase will occur approximately 2 hours after you eat. Everyone will see increases and decreases in blood glucose across the day. However, consistently high peaks can be a major problem if they are consistent and not controlled because over an extended period of time, having those high blood sugar levels can cause a lot of damage to your body. Some more serious results include hypertension, atherosclerosis, kidney failure, blindness and retina damage and higher susceptibility to infections. Another really common result of having that high blood sugar level for a long time is gout. So to recap from last day and today: These blood sugar peaks happen if your insulin is not working properly, what will happen is that your blood sugar level will spike right after you eat, since the sugar is trapped in the blood. And then your blood sugar will plummet low. These characteristic spikes and drops can
cause many problems as I just explained. And the newest research is finding that it really is this uncontrolled ups and downs that causes all the damage, not just the “highs”.

Many different things can also affect blood sugar levels. What you eat: if you eat something that is high in sugar or carbohydrates than your blood sugar will increase. This includes things made with white flour, and candy and treats and lots of processed foods. When you eat less processed flours, like whole grain and multigrain the sugar isn’t absorbed into your bloodstream as quickly and therefore you shouldn’t see as high of a spike. How much sleep you get: if you do not get much sleep than your blood sugar levels will also increase. If you are stressed: stress causes an increase in blood sugar levels. That’s why I got you to write those things down! Just to give you an idea of values, for T2D who are taking insulin, doctors usually say to try to keep blood sugar below 10, which would be anytime during the day. Another thing you can look for is right when you wake up, after you’ve been fasting, you can look at your blood sugar level and it is considered prediabetic if your blood sugar is 5.6 or higher and diabetic if it is above 7.0.

The last thing I want to mention is about your logbook. You should really see your logbook as something important and a great tool for yourself. It is also a very important piece of data for us. And as the weeks go on we will continue to practice self-monitoring, but don’t worry too much about that now, we’ll get to it. Try not however to think of it as homework that I am giving you, try to see it as a way for YOU to keep track of what you are doing for yourself. On Tuesday next week we are going to talk about how to make exercise goals and then you are going to practice self-monitoring your exercise.

To end off today I have a survey that I will need you to fill out.
TUTORIAL #3

As I talked about after the last class on Thursday, self-monitoring is a very powerful skill, simply monitoring your behaviour leads to more successful behaviour change. Last week you all became experts at monitoring your blood sugar levels, what you were eating and your mood. You all showed yourselves that you can do it! You should be very proud as you have not only joined this Phoenix class and taken the first step towards making a change but you also have learned and practiced a skill that will help you to stick with exercising even after this program is over. As with any new skill, however, it is important to practice it a lot to become good at it. Today I am going to show you how to self-monitor your exercise. It is so easy to forget what you did in the past week, as I’m sure you guys experienced last week when you filled in the survey asking you when you exercised in the previous week. By writing down and monitoring your exercise you will be able to see progress, and you will see if you are meeting your exercise goals.

Which brings me to the next very important component, before I can talk about self-monitoring of exercise we need to talk about making goals. A very big part of what self-monitoring is, is to look back and see if you are meeting your goals. This can help you to change your behaviour in the future so that you meet your goals. For exercising, Canada’s Physical Activity Guidelines recommends that asymptomatic adults do 150-minutes of aerobic exercise per week to get some health benefits! Aerobic exercise includes activities like walking, running, biking and swimming as opposed to resistance exercise, which would be activities like lifting weights, or doing push-ups or sit-ups. And this 150-minutes of aerobic exercise should be at a moderate-vigorous intensity, so at least a brisk walk. You guys come to this program twice a week and do aerobic exercise for about 30-minutes. So that equals about 60-minutes a week. But to reach your goal, you probably need to add one extra time per week doing something on your own, outside of this program. For example you could go for a walk after dinner one night of the week for an hour, or you could go for a 10-minute walk every night of the week. And the recommendation for 150-minutes per week is a minimum. Any exercise is good and more is always just an added bonus and you get even more health benefits the more that you do. So if you exercise 120-minutes a week you’ll even more benefit than if you exercise 90-minutes a week. Research also shows that if you make the goal yourself you have a higher chance of attaining it than if someone else makes it for you. So I am not going to tell you what your goal should be, I am going to have you each make up your own exercise goals for the next week. Before you do that I’m going to explain what makes a good goal. I’m going to use an acronym called “SMART” goals. This information about SMART goals is included in your logbook.

The “S” in SMART stands for specific: Be as specific as possible when you are making up a goal. Instead of saying, “I am going to exercise 3 times a week”, say “I am going to walk or bike around the block 3 times a week”. The more specific you can be the better!

The “M” in SMART stands for measurable: Make sure the goal that you make is something that you can look back at and actually measure to see if you’ve reached it. How much, how many, how will you know if you’ve reached your goal? Instead of saying “I am going to exercise more”, “say I am going to exercise for 100-minutes per week”, because then at the end of the week it is very easy to see if you’ve reached this goal. And with self-monitoring it will be extra easy to look back in your logbook and see if you’ve reached your goal! You’ll just need to look at your logbook calendar.
The “A” in SMART stands for **attainable**: When you are creating your goal make sure that you are being realistic and that your goal is attainable. Don’t make your goal that you are going to exercise 200-minutes per week if it is highly unlikely that you will be able to fit that into your schedule. It has to be a goal that you are going to be able to reach. Another example would be don’t make your goal that you are going to swim if you don’t have access to somewhere you can swim.

The “R” in SMART stands for **relevant**: Is the goal important for you? A goal to do 100 lay-ups every night might be an important goal for a basketball player but if you don’t want or plan to play basketball it probably isn’t very relevant to you.

The “T” in SMART stands for **time-framed**: Make sure that you include a time-frame for when you are going to complete your goal by. Instead of just saying that you are going to bike more, make a goal “I will bike for 30-minutes 3 times a week for the next 2 weeks”. You can see that in my example not only did I include a time frame for how I would exercise each time, but also for how long this goal was going to continue for (e.g. the next 2 weeks).

Ok. This was a lot of information that I provided you with. Does anyone have any questions? Just to give a recap.

- Canada’s Physical Activity Guidelines recommends that you do 150 minutes of exercise per week—for asymptomatic adults, for health benefits (e.g. better blood sugar control), but the more bouts the better
- This exercise refers to aerobic exercise of moderate to vigorous intensity, so at least the intensity of a brisk walk
- It is important to make your own goal, and this goal should be (does anyone remember what SMART stands for?) **specific, measurable, attainable, relevant** and **time-framed**
- I would like everyone to set a goal for the next week, but the next time I am going to talk to you will be next Thursday so you get 2 extra days to complete your goal this time

Now everyone make your own exercise goal about how many minutes you will exercise per week and write this into your logbook. Like I said, make sure your goal is your own and also make sure you don’t push yourself too hard. If you go too hard right at the start you could injure yourself and then you wouldn’t be able to do any exercise. You want to be able to see improvements but I suggest you start out slowly and build exercise into your life. I’m here to help if anyone isn’t sure about theirs or would like a suggestion. As well, share your goals with each other and you may get ideas, but make sure you make it your own!

Goals are all made. Now onto the part that you are all already pros at, self-monitoring! This week you aren’t wearing the continuous glucose monitors, so I am not going to be asking you to monitor your blood sugar, but this week we are going to practice monitoring your exercise! Like I keep telling you, self-monitoring has been shown countless times to make behaviour change more successful, that’s why it’s so important! And by writing down every time you exercise, at the end of the week you can look back at your logbook and feel proud by all of the exercise bouts you did! It will also help you see if you are meeting your goals. At the end of the week you can add up the number of minutes you exercised and see if you reached your goal. Can I have everyone go to the page in their logbook for this week. Ok, so this where I am going to get you to write and self-monitor your exercise bouts. The first row in the calendar says “Activity” so what you’d write in there is what activity you did, it might be walking, biking, swimming, or
Phoenix class and you might include some of the activities you did in the class that day, so today you could write ______________. The next slot is where you fill in the number of minutes that you did the exercise, called “Minutes”. Then we have a row called “Exertion” then in brackets it says “RPE 0-10”. This row is to fill in what we call “Rate of Perceived Exertion”. It gives a good idea of the intensity that you are working at, this is important so that when you look back you can see if you were exercising really hard, or not as intense. The way you rate it is on a scale of how hard you are exercising from 0 to 10, you can see in the bright green box 0 refers to “nothing at all”, so if you were sitting on the couch you probably wouldn’t feel like you were working at all. Then 3 refers to moderate, so if you felt like you were exercising at a moderate intensity and it goes all the way up to 10 which would be if you were exercising as hard as you possibly could, “very, very strong”. Kim talked about this scale on the first day. She described 0 as “sitting on the couch” and 10 as “you are so tired you need a taxi to drive you home”. The same exercise may feel moderate one day and strong the next day, this is normal, try to go with your gut instinct on this one. It is really important that you complete this logbook right after you exercise because a lot of things, especially rating of perceived exertion, will be easy to forget and in an hour you probably don’t really remember how you were feeling. When you come to Phoenix make sure that you always bring this logbook so you can fill it in before you go home and try to keep it at home in a place where you will remember to write in it right after you exercise. I want you to write in every time you exercise. No matter how big or small. So now, lets write in our first entry from class today! Let me know if you have any questions as you go along.

Good job making goals and self-monitoring everyone! I have an important comment now though, I want to be clear that to see these changes in blood sugar control and other health benefits you will have to work hard. It is not easy to incorporate exercise into your routine, and although self-monitoring is a skill that has shown to help people have great success I don’t want you to be fooled into thinking it’s an easy change. You guys should all be very proud that you have started to make this change.

So you all have an exercise goal and the last thing I’d like us to do is come up with a goal for the whole group for the remainder of this program, so about 6 weeks! Every week I am going to check in with your logbook and see how many minutes each person has done in the last week. But I would like if you guys came up with the goal number. How many minutes do you think you can complete in the next 6 weeks? If we said everyone did 60 minutes per week and there are 9 people that would mean in 6 weeks you’d be able to reach 3240 minutes! But if you come to the Phoenix class 2 times a week you will likely do about 60 minutes of exercise per week and I’d like you to try adding some outside of the class, so you need to come up with a number, how about 70-minutes each, that would mean just adding 10-minutes a day outside of these classes or 80-minutes each. And you need to also come up with a goal for this group goal. I am going to make a big board and bring it in. It needs to have a theme. It could be riding across Canada and each minute you do could equal a kilometer. Or it could be a tour of the Okanagan and you could bike through the wine orchards, and then climb Knox mountain and finish off by skiing down Big White.

Thank you everyone; now don’t forget to write all your exercise bouts in your logbook! I look forward to seeing you all on Thursday and remember to bring those logbooks!
TUTORIAL #4

To start off let’s chat about the amazing job you all did self-monitoring this past week!

- How did it go?
- Did anybody experience any challenges?
- Did you meet your exercise goal? It’s ok if you didn’t, it just means we might want to think about it and maybe adjust it for the next week.
- Where did you keep your logbook so that you remembered to write in it after you exercised?
- Did you fill in your logbook right away?

And look how far we’ve come on the group goal since we made it only a little over a week ago. Wow! You guys are really doing well, I’m very impressed! Most/some of you met your exercise goals, right now I’d like you to think about the goal that you made for the past week, and looking at your logbook see whether you reached your goal and if not how close you were. We are now going to take some time to make a new exercise goal for next week. I’ll be walking around so if you have any questions or you’d like me to see your goal I’d love to! If your goal last week is something that you want to stick to than that is ok too! Remember that Canada’s physical activity guidelines recommend 150 minutes of moderate-vigorous exercise a week. Also, do you remember what a “SMART” goal is (specific, measurable, attainable, relevant, time-frame)?

Does everyone have a goal now that they would like to work towards for next week? Awesome! So now that you are all really getting the hang of self-monitoring, this week you are going to put it all together. I am going to get you to monitor your exercise, and you are going to wear the continuous blood glucose monitor again so I am also going to get you to monitor your blood sugar and what you eat. There are two new rows in the calendar for exercise, can everyone please flip to that calendar now. See at the bottom, I’d like you to look at your continuous glucose monitor before you exercise and jot down what your blood sugar level is and then look at your monitor after you exercise and again write down what your blood sugar level is.

Do you remember this graph that I showed you last time? Just to orient you again, along the x-axis is time and here along the y-axis is blood sugar level. Each one of these red dots is a meal so you can see that after he ate his blood sugar went up. But the really cool thing is that he did the exact same thing for two days, with the only difference being that one day he exercised and the other day he didn’t and look at this, on the day that he did exercise his blood sugar was much more controlled. After eating he didn’t have nearly the same peaks and lows as on the day he didn’t exercise. That is amazing! Look at how powerful exercise can be. But the thing is, just like any medication, it only works for that one day, and then the next day they have to take the medication again. Exercise too only helps control blood sugar for a short period of time, that’s why it’s really important to fit it in more than just 2 days a week. Don’t wait until the Phoenix class to get your exercise bout in, do one on your own at home so that you can keep seeing those amazing benefits like blood sugar control!

I have a little experiment for everyone to try this weekend. Try to replicate what we did here and eat the exact same food for two days in a row, but on the second day do a bout of exercise and on the first day don’t exercise. While you do this I want you to keep close watch on your blood sugar levels on both days. See how high it goes up after you eat a meal, does it change after you did exercise? We will talk about what happened next Thursday. Does anyone have any questions about anything? Ok now I am going to get you to fill in a survey, and while you are doing that I am going to be giving people their continuous glucose monitors again. One last thing that I
wanted to go over again is how to take a blood sugar reading with the finger prick. So you hold this device and you cock this light blue button, hold it to your finger, and then press the small other light blue circle in order to prick yourself. Once you do that put a strip into the reader and then hold the end up towards the blood drop and wait. And then follow the instructions in your logbook that tell you how to enter this information into your device monitor. You will need to take the first blood sugar reading 2 hours after the continuous glucose monitor is inserted, then you will need to take another one within 6 hours of the first. After today you will be taking readings and entering them 3 times a day, right when you wake up, right before dinner, and then right before you go to bed. Any questions about that? Ok here are the surveys.
Pre exercise
--- Post exercise
TUTORIAL #5

I’m so excited to hear how the experiment went!

• Did everyone remember to do it? Let’s recap, on two days you ate the exact same food, on one day you exercised and on the other you didn’t and the whole time you monitored your blood sugar levels.

• Give out individual blood sugar graphs. So what did you notice about blood sugar levels?

• That’s amazing! Those changes, being able to see in your own body that one bout of exercise results in more controlled blood sugar levels for a whole day! How do you feel about that? Do you think it’s pretty cool? It just goes to show you, don’t wait for these Phoenix classes every week, go out on your own so that you can see those benefits more often!

I know I keep saying this but I am just really impressed about how well you are all doing self-monitoring. You’re really picking the skill up fast and with all this practice I can tell you are starting to get the hang out it. Are you finding it easier? Are you enjoying it? Do you like being able to look back at your logbook and feel proud for all of the exercise you’ve been doing? Is anyone experiencing any challenges? Or feeling like it’s difficult to keep doing it and finding it burdensome?

This coming week and for the next couple of weeks we are going to continuing with self-monitoring our exercise. As you guys saw exercise has wonderful health benefits and so it is really important that you start adding in additional bouts outside of the Phoenix classes.

And along with self-monitoring, it is really important that you set an exercise goal again. Does everyone remember what a SMART goal is? Good! Who reached their goal last week? We are going to now set a goal again. If you are happy with what your goal was last week then that is great and you can keep it, but if you would like you can change your goal this week depending on how it went last week. The “R” in SMART goals stands for realistic, so if you found out that maybe your goal wasn’t realistic than you can change it, or if you would like to add even more minutes than you can do that too! Ok, everyone make a goal now for the number of minutes you are going to exercise per week for the next two weeks.

We learned how to self-monitor and today I am going to teach you another skill that will greatly assist you to start exercising more and fitting in exercise outside of the Phoenix classes which kind of goes along with self-monitoring and goal setting. The skill is called “action planning”. It has been shown that people who use action planning have MUCH greater success following through with their intentions. Lots of people have good intentions but often we don’t follow through on them. I’m sure most of you have in the past or know someone who has made New Year’s resolutions but never manages to follow-through with them. It is common to make an intention to do something, like exercise, but then not follow-through. But action planning can help you to really achieve your intentions. So you may wonder, what is action planning? It is writing down the where, when and how. So it is planning for exercise and writing down the exact date, time, location and what you plan to do. Just like self-monitoring it doesn’t seem like it is a difficult task, however, just like self-monitoring it requires some practice. This is such an important skill to learn and practice though, as it will really be very, very helpful to you in order
to adhere to all of your exercise intentions and to get started at reaching your exercise goals. So can everyone please flip to this page in your logbook. Ok, as you can see there is a calendar in here for the next 3 weeks, until the end of the program. What I am going to get you to do is look at each week and make an action plan for exercise in order to reach your exercise goals. You need to include, what (so what activity are you going to do and with who), where (where are you going to do it), and when (what is the date and time that you plan to do this activity). So for an example, if your exercise goal was to exercise 150-minutes per week, then you may look at next week and on Tuesday and Thursday you would write Phoenix exercise class at the Nest at 2pm for 45-minutes. And then to fit in your next 60-minutes, you would think about your week and remember that on Friday night you don’t have anything going on so you could write 30-minute walk down Mission Creek with husband at 7pm after eating dinner. You would still have 30-minutes to fit in somewhere so maybe on Sunday morning at 9am you plan to go for a hike up Knox Mountain for 30-minutes. Ok, does everyone understand? Just to recap: it’s really important that you are very specific and give the what, the where and the when and it is important that you are making a plan that will allow you to reach your goal. Ok time for you all to make action plans for the next 3-weeks. And once you’ve made one if you feel comfortable share what your plan is with someone else in the class. Before we move on I just wanted to mention that this is a plan, however, it’s important to still be flexible. If you miss the session that you planned to do, instead of giving up just think of when you can fit it in instead. This is why self-monitoring is so important because you can look and see if you are reaching your goal, and if you missed a session you planned to do see if you still have time to make it up.

Awesome job making action plans! I think I saw most people’s plans and they looked great! Now when you look at that calendar you will see that, “oh today at 3pm I’m going to go for a walk around the block”, and you can plan it into your day. If you find that in 2-weeks you realize one of the plans you made for the last week isn’t going to work anymore you can go through and change it the week before so that you are still able to reach your goal. All that is left for today is a survey for everyone in my study. Remember this coming weeks to keep practicing self-monitoring your exercise and checking back to see if you are reaching your exercise goals.
Wow, today is the last day! First I just wanted to thank you all for being fabulous participants and agreeing to be part of my study. I really appreciate everything that you have done. I hope that you have also gotten something valuable out of being a part of my study.

Briefly, over the past 8 weeks, you have learned how to make exercise goals, how to self-monitor your exercise and most recently also how to make action plans. All of these skills will help you to keep up exercise even after you leave here today and no longer attend these classes. Keep making exercise goals, monitoring your exercise and making action plans and I have no doubt that you will be able to stay active even without this class. Don’t get me wrong, it will still be difficult but I know that these skills you all have now mastered will be a huge help along the way. You have really all come a far way and I am so proud, as you should be about the changes you’ve made in your life and the changes you are still striving towards. And when you do “fall-off the horse”, which is definitely going to happen, don’t worry just move on and start again. All of the amazing progress that you have made is not going to disappear in just 1-week but it might if you put it off for a long time. I suggest that if you fall off the horse sit down and make an action plan for the next week of exactly when, where and what you are going to do. That will help you to get right back into things.

I have made up a new logbook for you for the next 4-weeks to assist you along the way on making goals, monitoring your exercise and making action plans. Today it would be great if you could make a new exercise goal and then at the end of each week think about whether you’d like to stick with your goal or if you’d like to change it if it’s no longer fitted for you. Ok, everyone make a goal and if you need any help or you’d like me to see it let me know!

Great, I’d like to take a moment for the group to brainstorm about how you may reach your goals. I know a lot of you attend water walking and water aerobic classes. Any other ways you’re planning to fit your exercise in? Going for a walk? Re-joining a Phoenix class?

Ok, now that you’ve had a brainstorm I’m going to get you to write your action plans again 😊 If you need any help with them please let me know!

Awesome, I’d say you guys are all set now. Remember to keep monitoring your exercise and each week look back and make a new goal and a new action plan.

Today you will be getting $75 and then in 4-weeks time I will mail/drop-off to you the very last survey and when you have completed it you will receive your final $25. For me, this last survey is probably the most important with respect to data collection so please make sure that you complete it, or if you are moving or something has come up please let me know so that we can stay in contact. I want to give you a final thank-you for all of your help with my research and I wish you the best. I look forward to hearing from you all in a month! While I am giving out money now I have a survey for you to fill out here.
CHECK-IN Script #1 (Class #6)

Will be collecting logbooks to take photos of first week of pages completed (CGM, BG chart and Food chart).

**If added an entry since Tuesday (when giving back):**
I saw in your logbook that you exercised yesterday and you wrote it in your logbook! Awesome start to getting practice writing down your exercise after just one day, I’m impressed! The more you do it the easier it will get, just stick with it. And that exercise bout has brought you closer to meeting your exercise goal, good work!

**If didn’t add an entry since Tuesday (when giving back):**
You didn’t exercise yesterday but you’ve still got a whole week to practice writing down your exercise and lots of time to reach your exercise goal. I’ll check-in with you again next Tuesday to see how you are doing.

*If they say they did exercise but just didn’t write it in their logbook ➔* Well it’s only practice that will make it easier, just like any other skill. It’s great that you exercised but try to remember to write it down right after because if not than you may forget and then it will be difficult to see how you are doing. It is also important for me because it is data that I will be using in my thesis. Where are you keeping your logbook now? Perhaps if you put it in a more prominent place, like the kitchen counter or the bag you bring when you exercise, you will remember to fill it in right after exercise next time.
CHECK-IN Script #2 (Class #7)

At the beginning of class/before class starts ask to see logbook so that I can update the group goal.

Great start to our group goal! Look at us we are almost at (name of city we are approaching). Everyone has been doing an awesome job! I’m really proud of you guys and you should be too! Part of why we are doing this group goal is so that you can keep encouraging each other to exercise on your own so that we can reach Hawaii in 6 weeks and also to encourage each other to reach your own personal exercise goals. So remember to congratulate each other on a job well done.

If they added an exercise entry since last Thursday and are well on their way to reaching goal:
Wow you’ve really been doing an awesome job of this self-monitoring. It seems like you are starting to get the hang of it. Keep sticking with it; it will become less of a chore and more automatic. And you’ve already reached/are getting really close to reaching your exercise goal! Awesome work! On Thursday we will make new exercise goals for the next week.

If haven’t entered any exercise sessions yet/ are really far from goal:
You still have 2 days to fit in your exercise so that you can reach your goal. We will be making new goals on Thursday so perhaps this goal was a bit ambitious to start out with? i) If they have entered something: Despite perhaps not reaching your goal this week you have been doing an excellent job of monitoring your exercise and that alone is a difficult task so you should congratulate yourself on a job well done. Learning to self-monitor is a great step towards reaching your exercise goals. ii) If they haven’t entered anything yet except Phoenix: Try to fit in one exercise session tomorrow no matter how small it may be so that you can get some practice writing it in your logbook. You’ve still been doing a good job of entering in the Phoenix classes after you do them so I’m glad you’re getting some practice doing that.

If they say they did exercise but just didn’t write it in their logbook → Well it’s only practice that will make it easier, just like any other skill. It’s great that you exercised because it will help you get closer to your goal but try to remember to write it down right after because if not than you may forget and then it will be difficult to see how you are doing (if you are reaching your exercise goal). It is also important for me because it is data that I will be using in my thesis. Where are you keeping your logbook now? Perhaps if you put it in a more prominent place, like the kitchen counter or the bag you bring when you exercise or fridge or bedside table, you will remember to fill it in right after exercise next time.
CHECK-IN Script #3 (Class #9)

At the beginning of class/before class starts ask to see logbook so that I can update the group goal.

If they are doing well/ on track to reaching group goal: You guys are doing really well on the group goal, based on this pace it looks like you will reach Hawaii before the end of the classes. We may have time to travel somewhere else too!

If they are not doing well towards group goal: Ok, I know it’s not an easy task. We made this goal as a challenge and from what you tell me you are working hard to reach our goal. But we are not currently on track. How can we get back on track? It’s really important that everyone is working hard and holding up their end of the deal. You guys decided that each person could do 80-minutes per week of exercise. The 2 Phoenix classes amount to usually close to 60-minutes (30-minutes each) meaning that you would each need to fit in 20 more minutes. This could be a 10-minute walk after dinner two extra nights of the week.

1) Ask everyone how his or her new exercise goal is going?

If it’s going well: Keep up the great work! Writing down your exercise bouts must make it easier to see where you are at with your goal and whether you need to exercise more these next couple days in order to reach it.
   i) It’s good that you made this week a more challenging goal and writing down/monitoring your exercise is a great way to show yourself that you have done it! When you look back at your logbook and see all of the exercise you’ve been doing you might be impressed.

OR

   ii) You are really reaching your exercise goal quite easily, perhaps next week you’d like to make it a bit more of a challenge. It seems that you are quite good at fitting in all of this exercise. Maybe since you’ve been writing it down/monitoring it has really helped you to make a more fitting goal that will give you a challenge.

If it’s not going well→far from goal: You still have 2 days to fit in your exercise so that you can reach your goal. We will be making new goals on Thursday so perhaps this goal was a bit ambitious? It’s awesome though that you have been writing down and keeping track of your exercise because now you know that you need to either fit exercise in the next 2 days or maybe you need to really think about your goal and if it is a realistic goal for yourself? You would not be able to know if you were reaching your goal if you weren’t self-mintoring.

If it’s not going well→not monitoring: You might still be finding it difficult to remember to write down your exercise bouts. I just want to remind you how important it is to write down when you exercise. It really does help people to change their behvaiour, so in this case to exercise more and reach your exercise goal that you set for yourself. If you don’t write down when you exercise it becomes a lot more difficult to see if you are reaching your exercise goals.

2) Has anyone seen a relationship between days that they exercise and their blood sugar levels?
Write down any comments people may have to elaborate on and use as examples during the talk on Thursday, October 17, 2013.
CHECK-IN Script #4 (Classes #11, 12 & 13)

At the beginning of class/before class starts ask to see logbook so that I can update the group goal.

Ask participants how their action plans are going/ are they helping them to complete their exercise goals? Have they been able to stick with them thus far?

If yes:
Awesome, well keep up the great work. By making this action plan you are now getting close to reaching your exercise goal and you don’t have to think about it because you know that if you follow your plan you will reach your goal no problem. That’s why they work, because you don’t have to think so hard. But remember, there will likely be a day sometime where you miss the exercise that you had planned to do and remember that that is ok too. You can always make-up for the missed activity later. That’s why these action plans are so great because you know that now you need to think of a new time to fit that exercise in.

If no:
It’s totally ok that you haven’t followed your action plan completely. It’s actually good that you get to see this now because it is bound to happen sometime so now you can see that of course you are going to miss one of your plans once in a while. The important thing is that you make up for that missed one so that you can still reach your exercise goal. So you can look at your calendar again and see when a good time would be to make up for that missed exercise bout. That is why these plans work so well, they really keep you accountable.

If they hate making action plans:
Just like goal setting and self-monitoring, these things really do take time and practice. Do you remember the first time that I asked you to self-monitor what you ate and your blood sugar and exercise. It was really tricky, but then by the second time that you wore the device it seemed a bit easier. You were getting the hang of things and now you are doing an amazing job keeping track of all the exercise you’ve done! The reason that I showed you about action plans is because they are very good at helping people reach their goals. If you make an action plan than you are a lot more likely to be able to fit in all your exercise to reach your goal. Maybe because you don’t have to think so much, you just look at your plan to see when you’re going to do your exercise and it keeps you accountable. People have busy lives and if you don’t plan your exercise in advance you might miss a good opportunity to do it. When you plan your exercise ahead of time by making these action plans then you will be more likely to act when these opportunities arise. I’m getting you to practice making action plans now while I’m still so that by the time you are done this program and on your own you will know how to do it and hopefully it will feel easier.
Check-in SCRIPT #5 (Class #14)

At the beginning of class/before class starts ask to see logbook so that I can update the group goal.

After class right before participants get their monitors in again:
Ok everyone, for the next 5 days you are going to wear the continuous glucose monitor again for the last time. At the end of this 5 days we will be able to look at your blood sugar levels and see if they are different from when you started the program, now that you’re all exercising so much. This is it; you likely won’t get this opportunity again, so I really want you to pay close attention to how your blood sugar levels change with exercise. This is your chance to get to see first hand how good exercise is at controlling blood sugar and exactly what happens inside your own body after an exercise bout. Like I have mentioned before, research has shown that exercise can help control your blood sugar better for up to 24 hours! That’s very cool, right?

Just as a reminder of what you should be doing while wearing the device. 2 hours after you get the device you need to do a fingerprick and enter your blood sugar into the monitor as well as write it down here in your logbook. Then you need to do that 1 more time again before you go to bed. Starting tomorrow I am going to get you to do a finger prick 3 times a day, right when you wake up, before dinner and right before you go to bed. You need to write that value into your logbook and also enter it into the monitor. Right after you eat lunch I’d like you to look at your blood sugar level by pressing the ESC button on your monitor here and seeing what your blood sugar level is and write it in your logbook. You can do this anytime throughout the day. I’d also like you to be keeping track of what you eat during the day and keep monitoring your exercise!

Also with exercise, just like last time, please check what your blood sugar is right before you exercise and again right after by pressing the ESC button on your monitor device. This will help you to see the connection or relationship between exercise and blood sugar. You will get to see what exercise does for your blood sugar! Does anyone have any questions? Does anyone not remember how to do a fingerprick? If so let me know and I’d be happy to show you while I am putting your monitor in again.
CHECK-IN Script #6 (Class #15)

At the beginning of class/before class starts ask to see logbook so that I can update the group goal.

Ask participants if they’ve seen any connection between exercise and their blood sugar levels this time. Also, remind participants that on Thursday I will be bringing in their final graph and it would be really cool if they remember to bring their previous 2 graphs and that way we can observe if their blood sugar levels have changed at all since the start of the program, with the addition of exercise.

**If they are on track to reaching their exercise goal for this week:**
Wow you have really done an awesome job and I am quite confident that you will be able to continue to be able to make exercise goals self-monitoring and make action plans once you are on your own and I am not here to check in. You really picked-up these skills quickly. It’s important to keep remembering that using these skills really will help you to stick with exercise and will help you to fit more exercise in! On Thursday I will be giving you a new logbook that you will be able to use for the next 4 weeks and as data for me it will be really helpful for you to keep practicing all your skills but also, as a way to keep you exercising, it is very important that you keep using these skills.

**If they haven’t entered any exercise sessions yet/ are really far from goal:**
*First focus on something that they are doing well (goal setting/self-monitoring/action plans) and let them know that this skill they have acquired will help them to get exercising more and along with that to get all the amazing health benefits that go along with exercise (including better blood sugar control).*
All of these skills work towards helping you to fit exercise into your life and reach your exercise goals. They do take time and you’ve been doing well practicing. Thursday will be your last day here at Phoenix but that doesn’t mean you should stop practicing these skills. I will be giving you a new logbook on Thursday so that you can keep practicing these skills over the next month. It just takes time and I am confident it will become easier.
Appendix I: Picture of Continuous Glucose Monitor (CGM)
Appendix J: Logbook during 8-week Intervention

My Healthy Habits Logbook

Use this logbook to its full potential, by completing all of the activities with as much honesty and detail as possible, in order to guarantee that you get the most out of it!

Over the next 8-weeks I am going to teach you how to self-monitor and this logbook will be a crucial tool along the way. The more you use this logbook to practice self-monitoring, the easier it will be for you to make a health change in your life and stick with it!

Contact Kaitlyn anytime:
Lab phone: 250.807.8419
Kaitlyn’s phone: 250.859.6317
Email: k.bailey@alumni.ubc.ca

HEPL
Health and Exercise Psychology Lab
University of British Columbia
(250)807.8419
hepl.study@ubc.ca
hepl.ok.ubc.ca
This week:

- You will be wearing a continuous glucose monitor for 5 days.

- This will allow you to self-monitor your blood sugar.

- After you exercise, your blood sugar level is much better controlled (not as many “peaks”) for up to 24 hours!
On September 19, 2013, 2-hours after you receive your continuous glucose monitor a screen will appear on the monitor that will show “Meter BG Now”, to get rid of this screen press ESC than ACT.

When you see this screen you need to take a blood sugar reading and enter it into your continuous monitoring device. Please see the next page for instructions on how to do this.

Record your 2-hour blood sugar reading in your logbook here _____.

You will need to take one more blood sugar reading and enter it into your continuous glucose monitor on September 19, 2013 before you go to bed.

Record you blood sugar from September 19, 2013 before you go to bed here _____.

Other INSTRUCTIONS:

- Starting on Friday September 20, 2013, it is really important that you take 2 blood sugar readings a day, the first **right when you wake up** and the second **right before you go to bed**. Instructions for how to do this are on the following page. **If you have any questions please call Kaitlyn at (250) 859-6317.**

- Your continuous glucose monitor is waterproof so you can wear it in the shower or in a bath. We ask that you please **do not go in a hot tub** while wearing the device over the next 5 days.

- It is also important that you **do not take any Tylenol or other acetaminophen containing products** while wearing the monitor. This is because they interfere with the sensors ability to measure blood sugar.

- If your continuous glucose monitor falls out, or you have any problems with the device or have any questions regarding which medications you can use please call Kaitlyn immediately at (250) 859-6317.
Continuous Glucose Monitor Calibration Instructions

How to Take a Blood Sugar Reading to Enter into the Continuous Glucose Monitoring Device

1) Check the sensor icon on the top of the screen to make sure that it is properly connected:

This signal means that it is properly connected and you can move on to the next step.

If it looks like this first make sure that the monitor is close to your stomach. If it still looks like this call Kaitlyn at (250) 859-6317

Next you will need to take a blood sugar reading:

2) Wash your finger with warm water and soap and dry it with a towel.
3) Put a new strip into the glucose meter inserting the end with black and white stripes so that you can’t see the stripes anymore. Put the meter aside.
4) Cock the pin by sliding the light blue cocking device back until it clicks.
5) Press the end of the pin against your finger and press the small light blue button.
6) You need to create a blood drop about this size ●. Gently massage at the base of the finger if the blood drop is slow to create.
7) Touch and hold the drop of blood to the end of the strip with the thin yellow stripe on the top edge. Blood will be drawn into the stripe. Keep holding the drop of blood to the top edge of the test strip until the confirmation window is full.
8) Record this reading into your logbook.

Next you will need to enter this blood sugar number into your continuous glucose monitor:

9) Press MAIN MENU → Sensor → Enter Meter BG
10) The ENTER BG screen should show three dashes like in this photo:

![Example Display](image)

11) Using the up and down arrow keys, enter your blood sugar level so that it matches what came up on your meter.
12) To end press ACT.
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**BREAKFAST**

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**DINNER**

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October 1, 2013

This week:

- You will be making an exercise goal.
- You will learn and practice monitoring your exercise.
- By monitoring your exercise you will be able to see if you reached your exercise goal.
Canada’s Physical Activity Guidelines recommends that non-symptomatic adults exercise for 150-minutes of moderate-vigorous aerobic exercise every week.

Creating an Exercise Goal

My exercise goal is to exercise __________ minutes a week.

SMART GOALS

SPECIFIC: Be as specific as possible when you make a goal.

MEASURABLE: Make sure that at the end of the week you can measure whether or not you met your goal.

ATTAINABLE: Be realistic and make a goal that is attainable for you.

RELEVANT: Make a goal that is relevant and important to you.

TIME-FRAME: Include a time-frame of when you want to complete your goal by.

Make a goal that is your own! Don’t worry if it’s not the same as everyone else’s in the class. You are more likely to reach your goal if it is your own.
**Exercise Log Book Instructions**

In the following calendar write down every exercise bout you perform over the next week, including what you did ('Activity'), how long you did it for ('Minutes of Activity'), and how hard it felt ('Exertion'). Try to complete this logbook as soon after you finish exercising as possible.

<table>
<thead>
<tr>
<th>Oct 1-2</th>
<th>TUES</th>
<th>WED</th>
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<tr>
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<tr>
<td>Minutes of Activity</td>
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<tr>
<td>Exertion (RPE 0-10)</td>
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<table>
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<td>Minutes of Activity</td>
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</table>

**Rate of Perceived Exertion**

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

<table>
<thead>
<tr>
<th>Value</th>
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<tr>
<td>0.5</td>
<td>Very, Very Weak</td>
</tr>
<tr>
<td>1</td>
<td>Very Weak</td>
</tr>
<tr>
<td>2</td>
<td>Weak</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
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<tr>
<td>4</td>
<td>Somewhat strong</td>
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<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Very, very strong, Maximal</td>
</tr>
</tbody>
</table>
This week:

- You will be making a new exercise goal for the next week.

- You will be wearing a continuous glucose monitor again for 5 days.

- You will be practicing self-monitoring lots by monitoring your blood sugar, your diet AND your exercise!

- Sometime this week try an experiment: Eat the same food on 2 separate days, i) on the first day don’t exercise, ii) on the second day exercise! Did exercise affect your blood sugar?
# Exercise Log Book

**Instructions**

My exercise goal is to exercise _______ minutes a week.

**Rate of Perceived Exertion**

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

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<td>10</td>
<td>Very, very strong, Maximal</td>
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I exercised _______ minutes this week.

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Continuous Glucose Monitor

IMPORTANT

- On October 10, 2013, 2-hours after you receive your continuous glucose monitor a screen will appear on the monitor that will show “Meter BG Now”, to get rid of this screen press ESC than ACT.
- When you see this screen you need to take a blood sugar reading and enter it into your continuous monitoring device. Please see the next page for instructions on how to do this.
- Record your 2-hour blood sugar reading in your logbook here ______.
- You will need to take one more blood sugar reading and enter it into your continuous glucose monitor on October 10, 2013 before you go to bed.
- Record your blood sugar from October 10, 2013 before you go to bed here ______.

Other INSTRUCTIONS:

- Starting on Friday October 11, 2013, it is really important that you take 2 blood sugar readings a day, the first right when you wake up and the second right before you go to bed. Instructions for how to do this are on the following page. If you have any questions please call Kaitlyn at (250) 859-6317.
- Your continuous glucose monitor is waterproof so you can wear it in the shower or in a bath. We ask that you please do not go in a hot tub while wearing the device over the next 5 days.
- It is also important that you do not take any Tylenol or other acetaminophen containing products while wearing the monitor. This is because they interfere with the sensors ability to measure blood sugar.
- If your continuous glucose monitor falls out, or you have any problems with the device or have any questions regarding which medications you can use please call Kaitlyn immediately at (250) 859-6317.
Continuous Glucose Monitor Calibration Instructions

How to Take a Blood Sugar Reading to Enter into the Continuous Glucose Monitoring Device

13) Check the sensor icon on the top of the screen to make sure that it is properly connected:

This signal means that it is properly connected and you can move on to the next step.

If it looks like this first make sure that the monitor is close to your stomach. If it still looks like this call Kaitlyn at (250) 859-6317

Next you will need to take a blood sugar reading:

14) Wash your finger with warm water and soap and dry it with a towel.
15) Put a new strip into the glucose meter inserting the end with black and white stripes so that you can’t see the stripes anymore. Put the meter aside.
16) Cock the pin by sliding the light blue cocking device back until it clicks.
17) Press the end of the pin against your finger and press the small light blue button.
18) You need to create a blood drop about this size . Gently message at the base of the finger if the blood drop is slow to create.
19) Touch and hold the drop of blood to the end of the strip with the thin yellow stripe on the top edge. Blood will be drawn into the stripe. Keep holding the drop of blood to the top edge of the test strip until the confirmation window is full.

20) Record this reading into your logbook.

Next you will need to enter this blood sugar number into your continuous glucose monitor:

21) Press MAIN MENU ➔ Sensor ➔ Enter Meter BG
22) The ENTER BG screen should show three dashes like in this photo:

![ENTER BG Screen]

23) Using the up and down arrow keys, enter your blood sugar level so that it matches what came up on your meter.
24) To end press ACT.
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October 17, 2013

This week:

• You will make a new exercise goal

• You are going to try something new… ACTION PLANS! Action plans help you to reach your exercise goals.

• You are going to keep practicing self-monitoring your exercise.
**ACTION PLANS:** Today in class you learned about how ACTION PLANS can help you to follow through with your exercise intentions. Now you are going to make ACTION PLANS for the next 3 weeks.

How to make an ACTION PLAN:

1. Write down the what, where and when for your exercise plan. E.g. On Thursday, October 17th at 9:00am I am going to go for a walk at Mission Creek for 30-minutes.

2. Make sure that your ACTION PLANS are congruent with your exercise goals. So if your exercise goal is to exercise for 100-minutes a week make sure that you make sure that your ACTION PLAN exercise minutes add up to 100-minutes.

<table>
<thead>
<tr>
<th>THURSDAY</th>
<th>FRIDAY</th>
<th>SATURDAY</th>
<th>SUNDAY</th>
<th>MONDAY</th>
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</tr>
</tbody>
</table>

*Your action plans will help you to reach you exercise goals.*
My exercise goal is to exercise ________ minutes a week.

I exercised ________ minutes Oct 17-23.

Rate of Perceived Exertion

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

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I exercised __________ minutes Oct 24-30.
October 31, 2013

This week:

• Now that you have the skills you need, this week is your chance to show off everything that you have learned.

1) Write down your exercise goal.

2) Make an action plan.

3) Monitor your blood sugar, your diet and your exercise.
# Exercise Log Book

## Instructions

My exercise goal is to exercise _______ minutes a week.

### Rate of Perceived Exertion

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

### I exercised _______ minutes this week.

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<th>Oct 31 - Nov 6</th>
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Continuous Glucose Monitor

IMPORTANT

- On October 31, 2013, 2-hours after you receive your continuous glucose monitor a screen will appear on the monitor that will show "Meter BG Now", to get rid of this screen press ESC than ACT.
- When you see this screen you need to take a blood sugar reading and enter it into your continuous monitoring device. Please see the next page for instructions on how to do this.
- Record your 2-hour blood sugar reading in your logbook here ______.
- You will need to take one more blood sugar reading and enter it into your continuous glucose monitor on October 31, 2013 before you go to bed.
- Record you blood sugar from October 31, 2013 before you go to bed here ______.

Other INSTRUCTIONS:

- Starting on Friday November 1, 2013, it is really important that you take 2 blood sugar readings a day, the first right when you wake up and the second right before you go to bed. Instructions for how to do this are on the following page. If you have any questions please call Kaitlyn at (250) 859-6317.

- Your continuous glucose monitor is waterproof so you can wear it in the shower or in a bath. We ask that you please do not go in a hot tub while wearing the device over the next 5 days.

- It is also important that you do not take any Tylenol or other acetaminophen containing products while wearing the monitor. This is because they interfere with the sensors ability to measure blood sugar.

- If your continuous glucose monitor falls out, or you have any problems with the device or have any questions regarding which medications you can use please call Kaitlyn immediately at (250) 859-6317.
Continuous Glucose Monitor Calibration Instructions

How to Take a Blood Sugar Reading to Enter into the Continuous Glucose Monitoring Device

25) Check the sensor icon on the top of the screen to make sure that it is properly connected:

This signal means that it is properly connected and you can move on to the next step.

If it looks like this first make sure that the monitor is close to your stomach. If it still looks like this call Kaitlyn at (250) 859-6317

Next you will need to take a blood sugar reading:

26) Wash your finger with warm water and soap and dry it with a towel.
27) Put a new strip into the glucose meter inserting the end with black and white stripes so that you can’t see the stripes anymore. Put the meter aside.
28) Cock the pin by sliding the light blue cocking device back until it clicks.
29) Press the end of the pin against your finger and press the small light blue button.
30) You need to create a blood drop about this size ●. Gently massage at the base of the finger if the blood drop is slow to create.
31) Touch and hold the drop of blood to the end of the strip with the thin yellow stripe on the top edge. Blood will be drawn into the stripe. Keep holding the drop of blood to the top edge of the test strip until the confirmation window is full.
32) Record this reading into your logbook.

Next you will need to enter this blood sugar number into your continuous glucose monitor:

33) Press MAIN MENU → Sensor → Enter Meter BG
34) The ENTER BG screen should show three dashes like in this photo:

35) Using the up and down arrow keys, enter your blood sugar level so that it matches what came up on your meter.
36) To end press ACT.
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<tr>
<th>Time</th>
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Over the past 8-weeks during the Active Living with Chronic Disease program you learned and practiced:

- how to self-monitor exercise
- making exercise goals
- making action plans

With these skills you have everything you need to maintain the behaviour changes you made here at Phoenix.

Thank-you so much for your participation so far! In 4-weeks time you will receive the final survey for the study and your final $25. Remember to keep exercising and to write it down in your new logbook!

If you have any questions or concerns in the next month please don’t hesitate to contact Kaitlyn:

EMAIL: k.bailey@alumni.ubc.ca
PHONE: 250.807.8419
Appendix K: Logbook for 4-week Follow-up

My Healthy Habits Logbook: PART 2

Use this logbook to its full potential, by completing all of the activities with as much honesty and detail as possible, in order to guarantee that you get the most out of it!

You completed the first logbook, congratulations! I'm giving you this new one so that you can keep making exercise goals, action plans and self-monitoring your exercise. These skills are very useful in helping you stick with exercise and continuing to receive all the wonderful health benefits exercise has to offer!

Contact Kaitlyn anytime:
Lab phone: 250.807.8419
Kaitlyn’s phone: 250.859.6317
Email: k.bailey@alumni.ubc.ca

HEPL
Health and Exercise Psychology Lab
University of British Columbia

(250)807.8419
hepl.study@ubc.ca
hepl.ok.ubc.ca
Wow! You did it! You completed the 8-week Active Living with Chronic Disease Program!

You learned and practiced:
- how to self-monitor your exercise
- making exercise goals
- making action plans

It is your time to show off how good you are at these skills while you are on your own over the next month.

Keep using these skills and I have no doubt that you can keep up the exercise you’ve incorporated into your life during this program.

Think about all of the wonderful health benefits you will be getting from this exercise, such as better blood sugar control 😊
**ACTION PLANS:** Today in class you learned about how ACTION PLANS can help you to follow through with your exercise intentions. Now you are going to make ACTION PLANS for the next 3 weeks.

How to make an ACTION PLAN:

1. Write down the what, where and when for your exercise plan.
   
   E.g. On Thursday, November 7th at 9:00am I am going to go for a walk at Mission Creek for 30-minutes.

2. Make sure that your ACTION PLANS are congruent with your exercise goals. So if your exercise goal is to exercise for 100-minutes a week make sure that you make sure that your ACTION PLAN exercise minutes add up to 100-minutes.

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Your action plans will help you to reach you exercise goals.
Nov 7-13

Rate of Perceived Exertion

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

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My exercise goal is to exercise _______ minutes a week.

I exercised _______ minutes this week.

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<th>Nov 7-13</th>
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My exercise goal is to exercise _______ minutes a week.

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Your action plans will help you to reach you exercise goals.
Rate of Perceived Exertion

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue.

My exercise goal is to exercise __________ minutes a week.

I exercised __________ minutes this week.
Nov 28 - Dec 4

Rate of Perceived Exertion

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My exercise goal is to exercise _______ minutes a week.

I exercised _______ minutes this week.

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