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Advancing Type 2 Diabetes as a Condition for Primary Referral to Physiotherapy in Canada

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Abstract

Obesity and sedentary lifestyles are increasingly prevalent risk factors for type 2 diabetes (T2D), characterized by high blood glucose levels. Adoption and maintenance of healthy eating, physical activity, and exercise is recommended for lowering blood glucose and weight management. Physiotherapists are experts in prescribing safe, effective exercise to optimize health for people with co-morbid health conditions. However, T2D is not a primary condition for referral to physiotherapy services in Canada. The overall question guiding a series of three related studies was, *What is the current education and perspectives of Canadian physiotherapists about their role in managing T2D?* Study one surveyed and interviewed Canadian physiotherapy educators (n=10) as content experts of academic training of entry-to-practice physiotherapists. Participants held the opinion that physiotherapists are educated to assess for and manage diabetes complications, including peripheral neuropathy, lower limb amputations, and cardiovascular disease. Educators reported T2D is considered as a co-morbid health condition currently in curriculum. Study two detailed the perspectives of physiotherapists (n=21) through interviews. Physiotherapists agreed they would welcome the primary referral of people with T2D. They advocated physiotherapists can provide effective care for people with T2D, as a condition of primary referral, through education, prescription and supervision of exercise, and supporting healthy lifestyle behaviours. Lastly, study three examined the effectiveness of an 8-week supervised group education and exercise program, 'Get Fit for Active Living with Diabetes' (GFAL-D), for 12 people with T2D, exploring motivation at one-, six- and 12-month follow ups through interviews. Clinically significant improvements were observed for waist circumference, systolic blood

pressure, six-minute walk test (6MWT), timed up-and-go (TUG), 30-second chair stand test (CST) and arm curls. Follow up with a physiotherapy student was a motivator contributing to physical activity adherence within an episodic pattern of adherence throughout the year post-GFAL-D. In conclusion, entry-to-practice physiotherapists are trained to provide direct care employing exercise prescription and monitoring, behaviour change for living healthy lifestyles, and recognition of uncontrolled disease for referral to medical team members. Promotion of physiotherapy as a resource and partnership for referral from primary health care providers is needed to optimize health for people living with T2D.

Keywords

Type 2 Diabetes, Physical Therapy, Physiotherapy, Exercise, Physical Activity, Education, Curriculum, Surveys and Questionnaires, Qualitative Research, Mixed Methods

Summary for Lay Audience

Type 2 diabetes (T2D) is a common disease worldwide where individuals have high blood sugar levels. High blood sugar levels can result in complications including blindness and amputations. However, healthy eating habits and regular physical activity and exercise can help to lower blood sugar levels and prevent complications. This dissertation presents the results of three studies that provide evidence for physiotherapists, exercise specialists, playing a larger role in the management of T2D, which is not currently done in Canada. The first study described what and how T2D is taught in the physiotherapy programs across Canada using an online survey and phone interviews. Ten educators teaching physiotherapy students participated. Participants stated that T2D is taught in case studies and in lecture, however, participants agreed that T2D was not a focus because of lack of classroom time. In study two we explored physiotherapists' thoughts on T2D and the idea of people with T2D being referred to physiotherapy for their T2D. Twenty-one physiotherapists across Canada participated. Physiotherapists can help people with T2D with healthy lifestyles through exercise, either one-on-one or in a group setting. Our last study included an eight-week education and exercise program called the 'Get Fit for Active Living with Diabetes' (GFAL-D). Twelve people with T2D participated in the program and phone interviews one-month, six-months, and 12-months after the program to understand motivation to continue exercise. Physical function, the ability to perform everyday tasks such as walking, stair climbing, and lifting objects, was measured using the following tests: six-minute walk test (6MWT), timed up-and-go (TUG) test, 30-second chair stand test (CST) and arm curls. Physical function improved for all participants along with waist circumference and

blood pressure. One year after the program, participants described the motivators (i.e., wanting to improve/maintain health) and barriers (i.e., bad weather, lack of time) to participating in regular exercise.

Co-Authorship Statement

A version of chapter 3 has been peer reviewed and accepted for publication to *Physiotherapy Canada* in collaboration with Dr. Denise Connelly and Prof. Heather Gillis. A version of chapter 5 has been peer reviewed and accepted for publication to *Physiotherapy Theory and Practice* in collaboration with Dr. Denise Connelly, Dr. Chris Shields and Mireille Landry. Chapter 4 has been submitted for publication to *Physiotherapy Canada* and has been peer reviewed by the journal. I was the primary investigator for all studies presented in this dissertation and took the lead in the writing process. Dr. Denise Connelly, Prof. Heather Gillis, Dr. Chris Shields, and Ms. Mireille Landry have provided guidance, insightful feedback and revisions to the following studies and are acknowledged as co-authors. References for the three studies presented in my dissertation are provided below.

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Chapter 1

Introduction

Type 2 diabetes (T2D) is a global epidemic and in 2015, diabetes affected 3.4 million Canadians with a projected increase to 5 million by 2025 (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). T2D is characterized by chronic hyperglycemia due to the inability to use and produce insulin (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). Diagnosis of T2D includes fasting plasma glucose ≥ 7.0 mmol/L, two-hour plasma glucose ≥ 11.1 mmol/L during an oral glucose tolerance test (consuming 75 g of glucose in water), or a glycated hemoglobin (A1C) ≥ 6.5% (American Diabetes Association, 2016). Laiteerapong et al. (2019) reported an increased risk of mortality in patients with an A1C ≥ 7.0%. Chronically elevated blood glucose (i.e., ≥ 7.0%) can also lead to the development of diabetes complications including peripheral neuropathy, retinopathy, nephropathy, lower limb amputation, stroke, and cardiovascular disease (Ülger et al., 2018; Zheng et al., 2018) and is the leading cause of blindness and non-traumatic lower limb amputations in Canadian adults (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018).

Additionally, people with diabetes complications are at an increased risk of hospitalization, and leads to increasing health care costs, burdening the Canadian health care system (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). Direct and indirect health care costs due to T2D and diabetes complications, along with the aging demographic are expected to increase (Ohinmaa et al., 2004). T2D is predominantly diagnosed and managed by physicians and nurse practitioners (Roschkov & Chik, 2021; Sen, 2005; Yang et al., 2018). Physicians, nurses, and dietitians are

trained to provide T2D care consisting of healthy lifestyle counseling, medication adherence and self-monitoring techniques (Blackberry et al., 2013). Although not part of the health care team for T2D management, physiotherapists have the foundational knowledge and skills to provide education and exercise prescription for patients with chronic health conditions, including T2D (Dean et al., 2016). Historically, the role of physiotherapy is to treat injuries for body functions and structures (Dean et al., 2016), while focusing on activity limitations and participation restrictions (World Health Organization, 2001). However, with the growing prevalence of chronic health conditions, the role of physiotherapists should expand to accommodate the health care needs of these populations.

The National Physiotherapy Entry-to-Practice Curriculum Guidelines, presented by the Canadian Council for Physiotherapy University Programs (CCPUP), Canadian Alliance of Physiotherapy Regulators (CAPR), and Physiotherapy Education Accreditation Canada (PEAC) classifies T2D as a level 1 metabolic condition, where entry-to-practice physiotherapists are expected to be knowledgeable about the etiology, pathophysiology, clinical signs and symptoms, differential diagnoses, prognosis, current physiotherapy management and a base knowledge of non-physiotherapy interventions (CCPUP, 2019). However, it is unknown how T2D content is taught in the current physiotherapy academic curriculum, nor during clinical placements. Previous research has focused on T2D education in medical students (DelPrete et al., 2016; Devkota et al., 2014; Ho & Woo, 2016; Perlstein et al., 2016; Taylor et al., 2015); peer-reviewed literature informing education for other health professional students (e.g., nurses, occupational therapists, kinesiologists) was not found.

There is growing evidence supporting a direct role for physiotherapists as primary health care providers for T2D through exercise prescription (Harris-Hayes et al., 2020; Higgs et al., 2017). Exercise is important for the management of T2D, as regular exercise has been shown to improve insulin resistance and A1C (Kumar et al., 2019; Umpierre et al., 2013). Despite the well-established evidence for exercise interventions for people living with T2D (Akinci et al., 2018; Hordern et al., 2009; Lambers et al., 2008; Negri et al., 2010), supervised physiotherapy-led exercise programs in Canada were not found from an internet search. Supervised physiotherapist-led exercise interventions are safe and effective, resulting in clinically significant improvements in physical function and anthropometric measures (Higgs et al., 2016).

1.1 Exercise as a T2D Management Strategy

1.1.1 Effects of Aerobic and Resistance Training

Regular physical activity and exercise are key self-management strategies for people living with T2D. Physical activity is movement that expends energy above resting energy expenditure levels and can involve activities of daily living, leisure, sport, and exercise; whereas, exercise is planned, repetitive activity performed for the purpose of improving or maintaining health and fitness levels (Caspersen et al., 1985). Exercise consists of aerobic (e.g., walking, biking, swimming, running), resistance (e.g., weights, weight machines, resistance bands, bodyweight), flexibility (stretching of the major muscle groups) while incorporating balance training (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018).

Both physical activity and exercise provide physiologic and metabolic benefits for people living with T2D. A meta-analysis consisting of 34 articles examined the

effects of aerobic exercise alone or in combination with resistance exercise and reported significant reductions in A1C by -0.6% and -0.67%, respectively (95% confidence interval (CI) -0.98 to -0.27 and -0.93 to -0.40), systolic blood pressure by -6.08 and -3.59 mmHg, respectively (95% CI -10.79 to -1.36 and -6.93 to -0.24) and triglycerides by -0.3 mmol/L (95% CI -0.48 to -0.11 and -0.57 to -0.02) (Chudyk & Petrella, 2011). Another meta-analysis of eight randomized controlled trials (RCTs) reported that either high-intensity interval training (HIIT) or higher-intensity continuous exercise, defined as ≥64% VO_{2max}, resulted in further reductions in A1C compared to moderate- or lower-intensity continuous aerobic exercise (Liubaoerjijin et al., 2016). Additionally, aerobic exercise was found to significantly improve body mass index (BMI) (95% CI 0.06 to 0.39), peak oxygen consumption (95% CI -3.07 to -0.62) and maximum heart rate (95% CI 2.49 to 4.39) compared to resistance exercise alone (Yang et al., 2014).

Similarly, resistance exercise has been shown to improve A1C levels. An RCT consisted of a 16-week progressive resistance training intervention in 62 older adults with T2D (Castaneda et al., 2002). The progressive resistance training intervention was performed three times per week for 45 minutes. Exercises included five weight machine exercises (chest press, leg press, upper back, knee extension and flexion) with each performed for three sets of eight repetitions at a progressive intensity of 60-80% one-repetition maximum (1-RM) (Castaneda et al., 2002). The progressive resistance training program resulted in statistically significant reductions in A1C ($p=0.01$) and systolic blood pressure ($p=0.05$); as well as, increased muscle glycogen stores ($p=0.04$), increased lean mass ($p=0.04$), and a reduction in diabetes medication dosages ($p=0.03$) compared to a standard control group (Castaneda et al., 2002). Similarly, a meta-analysis

of 24 RCTs investigating the effects of resistance exercise compared to a non-exercise control group reported statistically significant reductions in A1C (95% CI -0.90 to -0.33) and insulin levels (95% CI -7.53 to -1.67) (Liu et al., 2019).

The Diabetes Canada Clinical Practice Guidelines Expert Committee (2018) provides recommended exercise parameters (frequency, intensity, time, type) for aerobic and resistance exercise, and recommends a minimum of 150 minutes per week of aerobic exercise in bouts of at least 10 minutes. Aerobic exercise should be performed at moderate-to-vigorous intensity (≥64% maximum heart rate) with no more than two consecutive days of rest (Diabetes Canada Clinical Practice Guidelines Committee, 2018). The recommended frequency for resistance exercise is two to three times per week. Resistance training should be progressive, increasing from one to three sets and repetitions progressing from 15-20 to eight repetitions as resistance increases (Diabetes Canada Clinical Practice Guidelines Committee, 2018). As aerobic and resistance training combined provide optimal benefits, the Diabetes Canada Clinical Practice Guidelines Committee (2018) recommends both aerobic and resistance training for the management of T2D.

Outcome measures of combined aerobic and resistance exercise for the management of T2D have been well documented in the literature (Balducci et al., 2010; Church et al., 2011; Magalhães et al., 2019; Schwingshackl et al., 2014; Sigal et al., 2007; Tomas-Carus et al., 2016). An RCT investigated the effects of aerobic, resistance or combined aerobic and resistance exercise on A1C levels compared to a sedentary control group of 251 people with T2D (Sigal et al., 2007). Combined aerobic and resistance exercise resulted in a greater reduction in A1C compared to aerobic exercise

alone (95% CI -0.83 to -0.09) and resistance exercise alone (95% CI -0.95 to -0.23); however, changes in blood pressure and lipid levels were nonsignificant (Sigal et al., 2007). Another RCT also examined the effects of aerobic, resistance and combined aerobic and resistance exercise on A1C levels in 262 adults with T2D (Church et al., 2011). The interventions were performed twice a week for nine months (Church et al., 2011). Statistically significant improvements in A1C were reported in the combined aerobic and resistance exercise intervention only ($p<0.05$) compared to the non-exercise control group (Church et al., 2011).

In addition to changes in A1C, exercise plays an important role in fitness levels. An RCT investigated safety and aerobic fitness of HIIT and moderate-intensity continuous training in 58 adults with T2D (Hwang et al., 2020). Exercise was performed four times per week for eight weeks using an all-extremity non-weight-bearing ergometer (Hwang et al., 2020). Exercise was reported to be safe with both HIIT and moderate-intensity continuous exercise and improved peak oxygen consumption (VO_{2peak}) by 10% and 8%, respectively. As well, exercise tolerance was increased by 1.8 and 1.3 min, respectively, compared to a non-exercise control group ($p\leq0.002$) (Hwang et al., 2020). These findings were further supported by Winding et al. (2017), who reported improved VO_{2peak} ($p<0.05$) during HIIT exercise compared to a non-exercise control group of 29 adults with T2D (Winding et al., 2017). In this study, HIIT consisted of 10 one-minute intervals at 95% of peak workload with one-minute of active recovery cycling three times per week for 11 weeks (Winding et al., 2017).

A meta-analysis of seven RCTs investigating the effects of strength using resistance bands in people living with T2D reported significantly improved lower-

extremity strength ($p<0.0001$) as measured using 1-RM for leg press (McGinley et al., 2015). Another systematic review and meta-analysis further examined the effects of various forms of resistance exercise and investigated hypertrophy versus muscular endurance training on muscular strength and cardiorespiratory fitness in adults with T2D (Acosta-Manzano et al., 2020). Hypertrophy strength training was defined as two to four days per week at 70-85% 1-RM and consisting of one to three sets of eight to 12 repetitions with the goal of increasing muscle mass size (Acosta-Manzano et al., 2020). Muscular endurance resistance training was defined as two to four days per week at <70% 1-RM consisting of two to four sets of 10 to 25 repetitions with the goal of increasing the endurance of muscles performing at a submaximal resistance (Acosta-Manzano et al., 2020). Both hypertrophy and muscular endurance resistance training were associated with increases in upper ($p=0.002$, $p<0.001$, respectively) and lower ($p=0.001$, $p<0.001$, respectively) body strength (as measured by 1-RM) after interventions of at least 4 weeks compared to control groups (Acosta-Manzano et al., 2020).

1.1.2 Physical Function and T2D

Physical function is the ability to perform everyday tasks including walking, stair climbing and lifting objects (Rikli & Jones, 1999). Clinical measures of physical function include the six-minute walk test (6MWT), the timed up-and-go (TUG) test, the 30-second chair stand test (CST) and arm curls, which measure aerobic capacity, agility, balance, and strength (Rikli & Jones, 1999). Alfonso-Rosa et al. (2013) reported that the 6MWT, TUG test, and the 30-second CST are reliable measures in adults with T2D, with

intraclass correlation coefficients (ICC) of 0.99, 0.98, and 0.92, respectively. However, the TUG test has not been validated in this population (Dixon et al., 2017).

RCTs have demonstrated that exercise interventions improve physical function in adults with T2D (Brun et al., 2008; Hordern et al., 2009; Hsieh et al., 2016; Lambers et al., 2008; Park & Lee, 2015; Szilágyi et al., 2019; Tan et al., 2012). An RCT consisting of twice weekly aerobic exercise for 45 minutes reported statistically significant improvements in 6MWT scores ($p=0.002$) after one-year compared to a non-exercise control group (Brun et al., 2008). Another RCT consisted of a 12-week resistance training intervention for 30 people with T2D (Hsieh et al., 2016). The resistance training intervention was three times per week using resistance bands to perform three sets of eight to 12 repetitions for eight exercises (Hsieh et al., 2016). Hsieh et al. (2016) reported between or within group statistically significant improvements for the five-time CST ($p=0.007$) and the TUG ($p=0.01$). RCTs consisting of combined aerobic and resistance training for adults with T2D have reported significant improvements for the arm curl test ($p<0.05$), 30-second CST ($p<0.05$) (Park & Lee, 2015), and the 6MWT ($p<0.01$) (Tan et al., 2012).

Physical function has been shown to be reduced in people with T2D as one study demonstrated increased time to complete the five-time CST and reduced leg extension strength in 60 men with T2D compared to age-matched healthy controls (Leenders et al., 2013). As well, Guerrero et al. (2016) reported increased TUG scores in adults with T2D and noted impairments in muscle mass and quality compared to aged-matched healthy controls. Decreases in physical function leads to increased risk of falling. One study of 168 patients with T2D (≥60 years) compared to 43 controls without T2D reported that

participants with T2D had a prevalence of falls twice as high as control participants ($p<0.05$), which was associated with increased TUG scores (Chiba et al., 2015). Another RCT investigated the effects of a strength and balance training program for adults with T2D and peripheral neuropathy (Venkataraman et al., 2019). After the six-month intervention, participants with T2D and peripheral neuropathy reported significant improvements in TUG scores ($p=0.032$) and balance confidence ($p=0.005$), which highlights the potential of strength and balance training in falls prevention (Venkataraman et al., 2019). Physical function outcome measures are already used in physiotherapy practice. Therefore, physiotherapists can implement physical function outcome measures during assessments for patients with T2D and use to monitor progression with interventions.

1.2 Role for Physiotherapy

1.2.1 Managing Diabetes Complications

Complications that arise from T2D that effect mobility and physical function include peripheral neuropathy, lower limb amputations, and stroke, which are conditions treated and managed by physiotherapists. Peripheral neuropathy is numbness or decreased sensitivity to pain and temperature, increased sensitivity to touch, parathesis, and pain in the foot and lower extremity, resulting in balance impairments and increased falls risk in this population (Ites et al., 2011). A systematic review investigated physiotherapy interventions for people with diabetes-related peripheral neuropathy (Jahantigh Akbari et al., 2020). Jahantigh Akbari et al. (2020) noted that weight-bearing exercise, including walking, resistance training and Tai Chi improved ankle and foot function, ankle range of motion, foot muscle strength, balance, and symptoms of

peripheral neuropathy (muscle weakness, pain, loss of balance, lower limb dysfunction). Other modalities that may help to improve the symptoms of peripheral neuropathy that can be performed by physiotherapists include acupuncture, electrical nerve stimulation, and low-level laser therapy (Jahantigh Akbari et al., 2020). Another study investigated the effects of sensorimotor training on balance and proprioception in people with T2D and peripheral neuropathy (Ahmad et al., 2019). Sensorimotor training included 10 exercises progressing every two weeks for eight weeks led by a physiotherapist (Ahmad et al., 2019). Sensorimotor training was found to improve TUG scores ($p=0.002$), one-legged stance with eyes open and closed ($p\leq0.041$), and proprioception ($p=0.026$) (Ahmad et al., 2019).

In 2011, 7708 Canadians required a lower limb amputation, with 65% or 5,010 related to T2D (Imam et al., 2017). Non-traumatic lower limb amputations, secondary to diabetes-related foot ulcers, are associated with a high rate of re-amputation (Imaoka et al., 2021), making rehabilitation essential for lower-extremity strengthening and reducing falls risk following amputation. The role of physiotherapy in the rehabilitation of a lower limb amputation is to provide compression therapy to reduce swelling and shape the limb for a prosthesis if the patient is a candidate (Hebenton et al., 2019). Other interventions include education and rehabilitation using a gait aid (e.g., wheelchair, walker), fitting of a prosthetic limb, and gait retraining using the prosthetic limb (Hebenton et al., 2019). Motor imagery is a tool that physiotherapists use during rehabilitation, which can consist of mirror therapy and self-directed visualizations, to reduce pain and facilitate normal movement patterns (i.e., walking, balancing, reaching) (Matalon et al., 2021). Motor imagery was performed for five to eight minutes three

times per week for four weeks progressing from simple to complex tasks in one case study (Matalon et al., 2021). Despite evidence supporting the role of physiotherapists treating and managing the complications that arise from T2D, there is a gap in the current health care system in Canada for the role of physiotherapists in the primary prevention of T2D and secondary prevention of diabetes complications.

1.2.2 Exercise Participation

A meta-analysis reported on the beneficial effects of exercise supervision for adults with T2D (Gordon et al., 2009). Supervision of exercise resulted in greater improvements in A1C, insulin resistance, blood pressure, BMI, waist circumference, aerobic capacity and strength compared to unsupervised exercise (Balducci et al., 2010). A prospective study investigated the effects of a supervised physiotherapist-led progressive resistance training intervention in 30 adults with T2D and was conducted in a physiotherapy clinic (Misra et al., 2008). The progressive resistance training intervention was performed three times a week for 12 weeks and consisted of two sets of 10 repetitions of six exercises where resistance was determined by 3-RM (Misra et al., 2008). Significant improvements were reported for insulin sensitivity ($p<0.0001$), A1C ($p<0.001$), and fasting glucose ($p<0.001$) (Misra et al., 2008). Another study of 25 people with T2D examined the effects of physiotherapeutic exercise on health-related quality of life including pain (Lucha-López et al., 2012). The intervention consisted of aerobic exercise, neuromotor reprogramming, exercises for joint stabilization and/or mobilization, and stretching (Lucha-López et al., 2012); of which 84% of participants had pain-related musculoskeletal dysfunction, 8% had neuropathic complications and 4% had vascular complications (Lucha-López et al., 2012). Fibrinogen, hip circumference,

and skinfold sum were significantly improved ($p<0.05$) after the intervention, which contributed to a decrease in cardiovascular risk (Lucha-López et al., 2012). Additionally, pain significantly decreased as measured using the visual analog scale ($p<0.05$) (Lucha-López et al., 2012). Although there is evidence for physiotherapy-led exercise interventions for adults with T2D, this is not part of current physiotherapy practice in Canada. Other examples of physiotherapist-led exercise interventions implemented throughout Canada for specific populations include: the GLA:D™ program for osteoarthritis (GLA:D™ Canada, 2022); pulmonary rehabilitation programs for people with chronic obstructive pulmonary disease (COPD) (Higashimoto et al., 2020) and, more recently, COVID-19 (Pancera et al., 2020).

Exercise interventions for people with T2D have been shown to be safe (Higgs et al., 2016; Kluding et al., 2015). However, Kluding et al. (2015) reported 57 nonserious adverse events after completing a 16-week aerobic exercise intervention in 18 sedentary people with T2D and peripheral neuropathy. Nonserious adverse events included joint and muscle pain, hypoglycemia, chest pain, and shortness of breath (Kluding et al., 2015). Emphasis on close monitoring of adverse events is recommended with initial exercise prescription in this population (Kluding et al., 2015), which is feasible during physiotherapist-led exercise interventions. Specifically, close monitoring of exercise intensity is recommended for sedentary people with T2D who are at an increased risk of a cardiovascular event, as previously sedentary individuals initiating vigorous-intensity exercise may be at greater risk (Franklin, 2014). Also, it is important to note that weight-bearing physical activity, consisting of supervised walking, lower extremity strengthening and balance exercises, did not increase the risk of foot ulcer development

or re-development in 79 participants with T2D and peripheral neuropathy (Lemaster et al., 2003). Exercise and physical activity did not worsen symptoms but rather helped to prevent foot ulcerations (Lemaster et al., 2003), and therefore, weight-bearing exercise helps to prevent diabetes complications.

Since 2011, the United Nations, World Health Organization, and the World Confederation for Physical Therapy prioritized the treatment and management of noncommunicable diseases, including T2D (Dean et al., 2014). Physiotherapists are well-positioned to assume a primary role in T2D management as they are trained to provide patient education about exercise participation and tailored exercise prescription to provide patient-centered care in a biopsychosocial model (Dean et al., 2014). Physiotherapy intervention is also cost-effective compared to pharmacological and surgical management and can provide patients with long-term follow up targeting behaviour change (Dean et al., 2014). In addition to the evidence supporting the implementation of supervised group exercise, physiotherapists can improve quality of life in people with T2D and its complications through pain management, weight management, and improving function and mobility with prescription of an individualized exercise program (Cade, 2008).

1.3 Implementation of Behaviour Change Strategies

1.3.1 Behaviour Change for T2D Management

Along with nutrition, physical activity and exercise are considered the first line of defense for the prevention and management of T2D. A systematic review and meta-analysis examined behaviour change techniques for the uptake of healthful nutrition and

physical activity in adults with T2D (Cradock et al., 2017). Four behaviour change techniques resulted in clinically significant reductions in A1C and included 'instruction on how to perform a behaviour', 'behavioural practice/rehearsal', 'action planning', and 'demonstration of the behaviour' (Cradock et al., 2017); all elements of the Social Cognitive Theory (Bandura, 1986). As well, supervision and group sessions with an exercise physiologist and dietitian were helpful (Cradock et al., 2017). Implementation of behaviour change techniques resulted in continued improvements in A1C at 12- (-0.28%, 3 mmol/mol) and 24-months (-0.26%, 2 mmol/mol) after the intervention compared to controls, highlighting the effects of behaviour change techniques in long-term adherence (Cradock et al., 2017). Additionally, the overall reduction in weight loss over 24-months was -3.73 kg ($p=0.002$) compared to controls (Cradock et al., 2017).

Selçuk-Tosun and Zincir (2019) investigated the effects of a motivational interviewing intervention based on the transtheoretical model in 50 adults with T2D. At the six-month follow-up, participants in the intervention group reported improved self-efficacy ($p<0.05$) and A1C levels ($p<0.05$) compared to the control group (Selçuk-Tosun & Zincir, 2019). Guicciardi et al. (2013) reported that self-efficacy is integral to progressing through the stages of change and was positively associated with physical activity levels. An RCT investigated the effects of a nine-month walking exercise intervention based on the transtheoretical model on metabolic markers, physical activity and behaviour change (Kaplan Serin & Citlik Saritas, 2021). At the nine-month follow-up, significant improvements were reported for A1C ($p<0.001$), blood pressure ($p<0.05$), cholesterol ($p<0.001$), and increased steps per day ($p<0.001$) compared to the control group (Kaplan Serin & Citlik Saritas, 2021). As well, a significantly higher number of

study participants were in the maintenance stage (of the transtheoretical model of behaviour change) with fewer in the precontemplation, contemplation, and preparation stage compared to the control group (p=0.00) (Kaplan Serin & Citlik Saritas, 2021).

A qualitative study explored different types of motivation in people newly diagnosed with T2D (Sebire et al., 2018) using the self-determination theory framework (Deci & Ryan, 2008; Ryan & Deci, 2000). Sebire et al. (2018) described many people newly diagnosed with T2D embody the various types of extrinsic motivation, specifically feelings of needing to comply with lifestyle recommendations, guilt about relapsing, and frustration with seeing progress. Some participants described intrinsic motivation, satisfying the basic psychological needs of autonomy, competence and relatedness, and an indictor of better health and wellness compared to extrinsic motivation (Deci & Ryan, 2008), which developed over time and was driven by improving health and quality of life (Sebire et al., 2018). A systematic review of 19 RCTs summarized interventions containing the self-determination theory and motivational interviewing for individuals with obesity, prediabetes (i.e., A1C 5.7-6.4%) (American Diabetes Association, 2016) and T2D (Phillips & Guarnaccia, 2017). Health care professionals responsible for delivering the interventions were dietitians, nurses, nurse practitioners and physicians and predominately focused on A1C and weight loss (Phillips & Guarnaccia, 2017). Despite physiotherapists receiving training on motivational interviewing and behaviour change in the current entry-to-practice physiotherapy programs in Canada (CCPUP, 2019), studies including physiotherapists, with specialised knowledge of exercise and T2D, that explore behaviour change in adults with T2D are lacking.

1.3.2 Implementation of Behaviour Change in Physiotherapy Practice

Entry-to-practice physiotherapy students in Canada are expected to be knowledgeable about behaviour change theories, assess stages of behaviour change in their patients and implement effective communication approaches to encourage behaviour change and motivation (CCPUP, 2019). The physiotherapy curriculum in Canada supports a biopsychosocial approach to patient care, which has supported evolution in the physiotherapy profession beyond the traditional focus of treating physical injuries (Dean et al., 2011; Dean et al., 2014; Elvén et al., 2015). Recently, post-graduate continuing education and training courses, offered by the Ontario Physiotherapy Association (2022) include motivational interviewing and behaviour change for physiotherapists.

The literature presents growing evidence for physiotherapists including behaviour change as a component of therapeutic interventions. A systematic review investigated the effectiveness of physiotherapists providing lifestyle counseling to their patients (Frerichs et al., 2012). The patient population of the seven studies included individuals who were inactive, had obesity, at risk for cardiovascular disease or diagnosed with T2D, and one observational study that did not focus on a specific health condition (Frerichs et al., 2012). Physiotherapists were either the sole health care professional or part of a multidisciplinary team who were responsible for promoting increased physical activity combined with methods for monitoring progress over time (i.e., weight, BMI, waist circumference, blood pressure, strength, aerobic capacity) (Frerichs et al., 2012). Frerichs et al. (2012) provided a narrative synthesis of the included studies and

concluded that physiotherapists were effective at providing lifestyle counseling for behaviour change at least in the short-term Further, Frerichs et al. (2012) advised physiotherapists to expect many of their patients to present with risk factors for lifestyle-related noncommunicable diseases, resulting in greater need for competency in counseling for behaviour change along with traditional therapeutic interventions.

More recently, an innovative tool, called the Health Improvement Card was developed by the World Health Professions Alliance for health professionals to assess for risk factors for noncommunicable diseases in the patient population (Bai et al., 2020). The Health Improvement Card collects patient characteristics and a scorecard that collects BMI, fasting blood glucose, cholesterol, blood pressure, diet, physical activity, smoking history, and alcohol use (Bai et al., 2020). An RCT assessed the implementation of the Health Improvement Card on lifestyle behaviour change influenced by physiotherapists in 171 community-dwelling adults aged 50 to 90 years old (Bai et al., 2020). In the intervention group, the Health Improvement Card was administered as well as lifestyle and exercise counseling (Bai et al., 2020). At the three-month follow-up, significant improvements were reported for BMI ($p<0.001$) and waist circumference ($p=0.024$) compared to a control group, which received a brochure about healthy lifestyle practices (Bai et al., 2020). Study participants in the intervention group categorized as low risk for developing noncommunicable diseases based on their physical activity levels and diet improved by 32.2% and 20%, respectively (Bai et al., 2020). The literature supports a greater role for physiotherapists in the management of T2D through exercise education and prescription; assessment and monitoring of outcome measures

including BMI, waist circumference, blood pressure, and physical function; and implementation of behaviour change practices.

1.4 Overview of Current Studies

The overall aim of this series of three related research projects was to provide evidence that the physiotherapy profession has the capability to care for patients with T2D as a primary condition for referral focusing on exercise interventions with the goals of lowering blood glucose, weight management, prevention of diabetes complications and improve or maintain function and mobility. The purpose of the first study was to first address T2D content and delivery in physiotherapy curriculum. Next, we sought to explore the potential for physiotherapists to play a primary role in T2D management and to understand the effectiveness of a physiotherapist-led group exercise program for adults with T2D. Although entry-to-practice physiotherapy students are expected to be knowledgeable about T2D (CCPUP, 2019), evidence suggests that currently practicing physiotherapists in Canada lack confidence in certain aspects of T2D counseling (Doehring et al., 2016). It was unknown how and what T2D content was currently being delivered to students in entry-to-practice physiotherapy programs in Canada. The first study, accepted for publication in *Physiotherapy Canada* (Janssen et al., 2022), aimed to address a potential gap between teaching expectations outlined by CCPUP (2019) and teaching practice. The primary objective of this study was to describe the teaching and learning of T2D content in entry-to-practice physiotherapy programs across Canada through an online survey and telephone interviews. As a metabolic condition, T2D is prevalent in cardiorespiratory, neurological, and musculoskeletal areas of physiotherapy practice (CCPUP, 2019).

T2D is a highly prevalent condition, where approximately 80% of patients referred to outpatient physiotherapy have diabetes (type 1 or type 2) or are at risk for developing T2D (Harris-Hayes et al., 2020; Kirkness et al., 2008). Although, often seen as a co-morbidity in physiotherapy practice, as evidenced in studies one and two, physiotherapists are well-equipped to provide education and exercise interventions for people living with T2D (Dean et al., 2016). Study two explored physiotherapists perspectives on treating patients with T2D in current practice and as a potential primary condition for referral in outpatient clinical and community settings across Canada. This study explored physiotherapists viewpoints on the current funding model, referral system and accessibility issues for physiotherapy services. Participants discussed possible interventions, including one-on-one treatment sessions emphasizing motivational interviewing and behaviour change strategies (Fortune et al., 2019; O'Halloran et al., 2014; Pinheiro de Freitas et al., 2020) and supervised group exercise, referencing the GLA:D^{TM} program as one example of an evidence-based physiotherapist-led group exercise program for patients with osteoarthritis (Roos et al., 2021).

Lastly, study three was a mixed methods study to understand the influence of an eight-week education and exercise program, the "Get Fit for Active Living with Diabetes" (GFAL-D) program, on clinical outcome measures including physical function, BMI, waist circumference, self-reported fasting blood glucose, and blood pressure as well as motivation towards exercise one-year after completing the program. Physical function was measured by clinical tests already performed by physiotherapists and consists of the 6MWT, TUG, 30-second CST, and arm curls (Rikli & Jones, 1999). The development of diabetes complications can have a negative impact on physical

function. Peripheral neuropathy was associated with a significant increase in TUG scores ($p=0.002$) and people living with T2D and peripheral neuropathy were at an increased risk of falls secondary to impaired balance (Timar et al, 2016). With T2D more prevalent in the aging demographic, more than one third of older adults fall once per year, with close to one third resulting in injuries that impair mobility and independence (Stevens, 2005). A cross-sectional study reported increased risk of falls were related to older age (>65 years), longer duration of T2D and a diagnosis of diabetes complications (Yokomoto-Umakoshi et al., 2017). Physiotherapists are trained to assess falls risk and provide exercise programming for falls risk prevention (Lusardi et al., 2017). Therefore, the primary objective of study three was to quantify changes in physical function as well as self -reported fasting blood glucose, blood pressure, BMI, and waist circumference. A group environment provides social support, which was emphasized as a motivator to continue exercise in both studies two and three. Social or peer support has also been reported to improve T2D management and decrease T2D-related hospital admissions (Johansson et al., 2017; Whittemore et al., 2005). Therefore, the second objective was to explore motivation towards exercise adherence at one-year follow up.

1.5 References

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Chapter 2

Research Methods

2.1 Paradigmatic Position

My paradigmatic position aligns with pragmatism, as I resonate with the practicality of finding solutions to pressing problems in health care; exploring how to better care for people with T2D. Pragmatism as proposed by Dewey (2008) emphasizes the human experience (Dewey, 2008; Morgan, 2014). Morgan (2014) stated, "experience is built around two inseparable questions: What are the sources of our beliefs? and, what are the meanings of our actions?" (p. 2). Dewey (2008) elaborates on the concept of experiences, whereby one's set of beliefs from prior experiences can influence current and future actions, shaping future experiences. Experiences may be habitual, actions that do not require conscious decision making, or active, that is, requiring careful decision making and reflection (Morgan, 2014). According to Dewey (2008), scientific inquiry requires active engagement in experiences to problem solve and reflect throughout the research process.

A pragmatic approach to scientific inquiry involves a 3-step approach: i) identifying a problem considering multiple perspectives, ii) planning how to address the problem considering the potential benefits and consequences, and iii) taking the best approach to address the problem after careful evaluation (Morgan, 2014). With an emphasis on beliefs and actions, one may cycle through numerous scenarios of possible actions and evaluations before a solution is achieved (Morgan, 2014). Dewey's (2008) way of thinking focuses on the scientific inquiry as opposed to traditional schools of

philosophy. Pragmatism, according to Dewey (2008) asks, ‘What is the nature of human experience?’

I often had difficulty labeling my paradigmatic position and found myself in the middle of post-positivism and constructivism, as I believe that the interpretations of our experiences are unique, however, our interpretations are limited by the world we live in. Post-positivism acknowledges an imperfect reality, where ‘true’ reality cannot be obtained because “human intellectual mechanisms are flawed and that life’s phenomena are basically intractable” (Ponterotto, 2005, p. 129). The goal of post-positivism is to determine a cause-and-effect relationship of a phenomenon. Therefore, post-positivism lies within a critical realist ontology, acknowledging that there is a ‘true reality’ but that it can only be measured imperfectly with an epistemological view of modified objectivism (Ponterotto, 2005). In contrast, a constructivist paradigm adopts relativism, where the researcher assumes multiple realities constructed by the individual (Ponterotto, 2005). The epistemological lens of constructivism is that knowledge is co-constructed between the researcher and researched through “interactive dialogue and interpretation” (Ponterotto, 2005, p. 129).

Dewey (2008) claims that ontologically, the views embodied by post-positivism and constructivism are both valuable when it comes to the human experience. “We are not free to believe anything we want about the world if we care about the consequences of acting on those beliefs” (Morgan, 2014, p. 4). Biesta and Burbules (2003) describe the ontological position of Deweyan pragmatism as transactional realism, meaning that there is a continual interaction between the individual’s experience and the world they live in. Therefore, Deweyan pragmatism assumes reality is being continuously reconstructed

through transactional or an exchange of experiences between the researcher, participants, and the world to produce knowledge (Garrison, 1994; Hall, 2013). My ontology is based on ever changing human experiences with an orientation to solving practical problems in health care (Frey, 2018). Pragmatism acknowledges culture and context as vital components to understand experiences and truths (Shaw et al., 2010; Weaver, 2018).

Epistemologically, Morgan (2007) argues that knowledge is created by researchers answering important questions about the social world using methods that best answer the research question. Pragmatism believes that knowledge creation is an "active process of inquiry that creates a continual back-and-forth movement between beliefs and actions" (Morgan, 2014, p. 5). From a pragmatic lens, knowledge exists within the world beyond human experiences, but to know it, it must be experienced by humans (Allemang et al., 2021). Pragmatism does not necessarily possess ontological and epistemological views as other philosophical lenses; however, pragmatism acknowledges the different approaches to inquiry (Morgan, 2014). Instead, pragmatism produces one kind of knowledge based on the purpose of the research as well as producing knowledge in a certain way through the type of research methods employed (Morgan, 2014). Hall (2013) describes knowledge generation as "temporal and embedded in and generated through our experiential transactions" (p. 17). Therefore, the three studies presented in this dissertation represent current perspectives of educators, physiotherapists and adults with T2D. Knowledge was generated by sharing of experiences and knowledge between myself and participants through one-on-one semi-structured interviews.

Hall (2013) argues pragmatism from the works of Dewey inquires about societal problems and "accomplishes contextual sensitivity and tangible processes for how inquiry and credible evidence are achieved" (p. 17). Hall (2013) also describes that pragmatism takes "action in an intelligent way" (p. 17), which begins with identifying a problem in society and noting the complexity of individual experiences and perspectives. Intelligent action is the ability to inquire about these sets of beliefs and actions to address the problem (Hall, 2013).

A pragmatic philosophy lends well to research in health care. Allemang et al. (2021) discusses the aim of conducting research in patient care includes "conducting research that aligns with patient-identified priorities and generating study findings that can be used to improve health systems" (p. 41). Clinical implications with pragmatic research in health care seek to make change that is meaningful to patients, clinicians, and systems (Allemang et al., 2021). As such, the overarching aim of this dissertation is to highlight a gap in exercise counseling and participation for people living with T2D. Physiotherapists, experts in exercise education and prescription, could improve patient care for this population and support ongoing T2D self-management.

2.2 Methodology

A qualitative descriptive design was employed to the following three studies presented in this dissertation. The aim of our research was to provide descriptions of study participants experiences and perspectives (Sandelowski, 2010). Qualitative descriptive research is also referred to as "generic qualitative" research in the literature, which is applied when it is not necessary or appropriate to associate the research being conducted to more traditional philosophical methodologies (Caelli et al., 2003).

Qualitative research provides straightforward descriptions of the data, thereby is qualified as less interpretive than other methodologies (Sandelowski, 2000). As such, qualitative descriptive research is often conducted using a pragmatism philosophy (Neergaard et al., 2009). Neergaard et al. (2009) describes that the aim of qualitative descriptive research is to provide "a rich, straight description of an experience or event" (p. 53). Pragmatism and qualitative descriptive research allow for the flexibility of research methods and multiple methods for data collection may be used to understand an experience (Allemang et al., 2021). Sandelowski (2000) discusses the concept of descriptive validity as a key characteristic of qualitative descriptive research in that the researchers and participants are part of the same social world, such as in a health care context, and would agree the findings are an accurate depiction of events or experiences.

Bradshaw et al. (2017) describes the qualitative descriptive design as inductive and emic, whereby interviews are subjective experiences of the participants but is presented as meaningful interpretations from the researchers. Therefore, the researcher is involved in data generation not only through interpretation but also influences participant responses through active dialogue (Bradshaw et al., 2017). During data analysis, qualitative descriptive researchers remain close to the data and emergent themes are "in a language similar to the informants' own language" (Neergaard et al., 2009, p. 53). I acknowledge that my role as the researcher was to be an active member in data generation. The interview guide was semi-structured, which allowed me to engage in conversation with participants through sharing of information and experiences.

A systematic review sought to understand the characteristics of qualitative descriptive studies (Kim et al., 2017). Fifty-five qualitative descriptive studies were

included in the review, which provided inconsistent or vague descriptions of qualitative descriptive design (Kim et al., 2017). Lacking from the articles was a rationale for using a qualitative design (Kim et al., 2017). It is recommended that researchers provide a clear definition of qualitative descriptive research, justify the appropriateness of using qualitative descriptive, and provide details regarding the methods being used (Kim et al., 2017). Caelli et al. (2003) discusses that researchers need to address the following for credible qualitative descriptive research: theoretical position of the researcher(s), the lens used for data analysis, methodology and methods are coherent and appropriate, and rigour. The following sections will discuss the research methods used, strategies for conducting rigorous research and my presuppositions in a statement of reflexivity.

2.3 Methods

2.3.1 Study Sites, Recruitment, and Participant Sampling

Study one

For study one, we utilized purposive sampling to recruit faculty members or clinical instructors involved in teaching or knowledgeable about T2D in the 15 entry-to-practice physiotherapy programs Canada. The 15 universities included: University of British Columbia, University of Alberta, University of Saskatchewan, University of Manitoba, McMaster University, Queen's University, University of Ottawa, University of Toronto, Western University, McGill University, Université de Montréal, Université de Sherbrooke, Université du Québec à Chicoutimi, Université Laval, and Dalhousie University. Purposive sampling is an appropriate sampling technique for qualitative descriptive research as it recruits participants that have a shared experience in the phenomenon being studied (Palinkas et al., 2015). I did not have specific criteria on what

T2D content was taught and the quantity taught in each course for the inclusion criteria to recruit participants with a wide range of experiences, knowledge-base and awareness on T2D content (Doyle et al., 2020). Although I aimed to recruit participants from French-speaking schools, participants not fluent in English were excluded. This exclusion criteria was set as I was conducting the interviews and am only fluent speaking and writing in English. I emailed each Program Chair from the 15 physiotherapy programs in Canada with a description of the study including the link to the Qualtrics®^{XM} survey and asked the Program Chairs to distribute the email to faculty members or clinical instructors that teach or are knowledgeable about T2D content in the current physiotherapy curriculum. Interested participants were then able to access the Qualtrics®^{XM} link which included the letter of information and consent form prior to starting the survey (see Appendix B). Providing consent triggered access to the survey. After completion of the survey, participants were asked permission to be contacted via email for participation in a telephone interview. Consent was obtained by participants providing their email to be contacted. Verbal consent was obtained prior to starting each interview. No participants were excluded based on the inclusion and exclusion criteria and all participants were English speaking.

Study two

We used purposive sampling to recruit licensed physiotherapists currently working in community or outpatient clinical settings across Canada. Our aim was to explore a potential opportunity for physiotherapists providing care for community-dwelling adults living with T2D. Physiotherapists with experience treating patients with T2D as the primary condition of referral, as a co-morbidity, or treating T2D-related

complications (e.g., peripheral neuropathy, amputation) were included. We wanted to capture a broad range of experiences because we wanted to achieve maximum variation (Sandelowski, 2000). Participants who were not currently registered with their respective College or currently practicing in a community or outpatient clinical setting were excluded. Notably, no respondents expressing interest were excluded from participation and all participants discussed their experiences in a wide range of physiotherapy settings. An invitation to participate in our study was written in English and emailed to the following organizations to distribute to their members: The Canadian Physiotherapy Association (CPA); the Orthopedic Division of the CPA; and each provincial and territorial Association and College of physiotherapists in Canada. The email with the description of the study included my email address; interested participants were invited to contact me via email. I then emailed interested physiotherapists the letter of information and consent form (see Appendix H). Eligible participants signed the letter of information and consent form either digitally or signed and scanned and returned to me via email. Once written consent was obtained, the telephone interview was scheduled and conducted.

Study three

We employed a mixed-methods case series design using purposive sampling for study three (Dekkers et al., 2012; Fetters et al., 2013; Kooistra et al., 2009). Participants were recruited from family physician offices, health team clinics, or community programs (e.g., Boys and Girls Club, Kiwanis Seniors' Community Centre) by posting flyers in reception or waiting rooms, community information bulletin boards and/or sitting in-person with an information booth. Further, flyers were posted on an online

bulletin board for employees at London Health Sciences Centre in London, Ontario. The Canadian Centre for Activity and Aging (CCAA), which developed the GFAL-D program and provided the training for the GFAL-D and Senior Fitness Instructor programs, is in London, Ontario and hosted the study. Included participants were ≥ 18 years, had a clinical diagnosis of T2D (glycated hemoglobin (A1C) ≥ 6.5%), owned a smartphone or tablet, had cognitive and physical ability to participate in an education and exercise program, and were fluent in English. Individuals with diabetes complications (e.g., neuropathy, amputation) were included if they: a) had medical clearance from their primary care provider; and b) were able to physically participate in an exercise program. Study volunteers taking insulin or engaged in regular physical activity or exercise within the last month defined as scoring 'high' on the International Physical Activity Questionnaire (IPAQ) (see Appendix M) were excluded. The IPAQ (Craig et al., 2003) was used to identify participants as engaging in low, moderate, or high physical activity levels prior to participation in the GFAL-D program based on Metabolic Equivalent for Task (MET) minutes per week (MET-minutes/week). Participants were asked to complete the IPAQ to determine current physical activity levels for eligibility. The letter of information and consent was presented to participants explaining the nature of the study, benefits/risks, and confidentiality (see Appendix L). Once written consent was obtained, volunteers were screened for eligibility. Interested volunteers completed the Physical Activity Readiness Questionnaire (PAR-Q), a well-established pre-exercise screening tool (Warburton et al., 2011). If interested volunteers answered 'no' to all questions, they were able to participate in gradual physical activity and exercise, that is at the level of the GFAL-D intervention. If volunteers answered 'yes' to one or more

questions, they required medical clearance from their family physician. Volunteers who required medical clearance to exercise and interested in participating had their family physician complete the Physical Activity Readiness Medical Examination (PARmed-X) (Warburton et al., 2011).

Sample size was based on two factors: 1) feasibility and difficulties with recruitment and 2) information power proposed by Malterud et al. (2016), whereby the amount of information the sample has, and the relevancy of that information dictates the sample size for a study (Malterud et al., 2016). In particular, study three posed challenges recruiting adults with T2D in London, Ontario. Barriers to recruitment were related to physical ability and most notably, interest in exercise participation. Difficulties with recruiting older adults with T2D into lifestyle intervention studies were also noted by Miller et al. (2016). Our sample size for studies one and two were guided by the concept of information power rather than 'saturation' of themes, with is rooted in grounded theory (Malterud et al., 2016). With information power, sample size is guided by: 1) a broad or narrow study aim; 2) whether participant experiences are diverse or specific; 3) whether or not an established theory was applied to the research; 4) the quality of dialogue during interviews and expertise of the interviewer; and 5) whether a case (in-depth analysis of a few participants) or cross-case approach was taken during analysis (Malterud et al., 2016).

2.3.2 Data Collection

Study one

We collected a description of educators' experiences and perspectives teaching T2D content in entry-to-practice physiotherapy programs using an online survey and

one-on-one semi-structured telephone interviews conducted between October 2019 and November 2020. We designed a 24-item online Qualtrics®^{XM} survey to explore educators' professional background, T2D curriculum content, confidence teaching T2D content, importance of teaching T2D content, and perspectives on student preparedness (see Appendix C). Our online survey was modeled after a survey study designed by Bramley et al. (2018), which addressed motor learning content in entry-to-practice physiotherapy programs in Canada. The online survey consisted of multiple choice, 5-point Likert scale (e.g., 1=not prepared, 5=very prepared), level of agreement (e.g., strongly agree, strongly disagree) questions and questions with a textbox for open responses.

We sought to explore T2D content in the current physiotherapy curriculum, educators' thoughts on teaching T2D content and its value in physiotherapy curriculum, and the role of physiotherapy in the management of T2D using interviews. All educators were invited to participate in a second interview to deepen our understanding of emerging themes and clarify responses from the first interviews (see Appendix D and E for interview guides). Probing questions were used to elaborate on specific experiences, course assignments, and teaching methods. The interview guide from the first interviews was developed by my PhD supervisor, Dr. Denise Connelly, and myself. Upon review of the emerging themes from the first interviews, the interview guide for the second interviews were developed by myself and Dr. Denise Connelly in conjunction with my PhD advisory committee. See Appendix F for the copyright release form from *Physiotherapy Canada.*

Study two

We conducted one-on-one telephone interviews to explore physiotherapists' perceptions and experiences treating adults with T2D. Interviews were semi-structured (see Appendix I for interview guide) and were conducted between November 2020 and August 2021. Dr. Denise Connelly and I, in collaboration with my advisory committee, one with clinical expertise in the physiotherapy profession and one with an extensive background in qualitative research, developed the interview guide. The interview guide was designed using the Integrated Care for Chronic Conditions (ICCC) and Healthcare Access Barriers (HCAB) models (Carrillo et al., 2011; Nuño et al., 2012). The ICCC model integrates community partners, interdisciplinary health team and patients to improve health outcomes for people living with chronic conditions (Nuño et al., 2012). The HCAB model organizes barriers to accessing healthcare services into financial, structural, and cognitive (Carrillo et al., 2011). In brief, the interview started with asking participants to share their experiences treating patients with chronic health conditions broadly and then narrowing in on T2D specifically. Participants were asked to share their experiences and perspectives on addressing and managing T2D, sharing knowledge on community resources, current mode of care in their community, as well as barriers with accessing physiotherapy services.

Study three

We conducted a mixed methods case series study. The purpose of case series studies is to examine an intervention in patients with the same diagnosis without a control group (Kooistra et al., 2009). The benefits of case series studies are that patient samples often present more heterogeneity compared to RCTs, thereby, may be a better representation of the 'real world' in a clinical setting (Kooistra et al., 2009). However, it

is important to note that cause-and-effect relationships cannot be made from the findings of this study but can help design more robust studies, including RCTs (Kooistra et al., 2009). Researchers have different perspectives when it comes to mixed methods research (MMR). Hesse-Biber and Johnson (2013) comment that some researchers view MMR as a methodology without the research based within a paradigm, while other researchers believe you can blend different ontologies and epistemologies in a research study. However, in this study, my approach to conducting MMR was focusing on the 'mixing of methods', while remaining coherent with my stated ontology and epistemology within a pragmatic paradigm. Our mixed methods study followed a case study framework as proposed by Fetters et al. (2013). In MMR, a case study framework includes "both qualitative and quantitative data ... to build a comprehensive understanding of a case, the focus of the study" (Fetters et al., 2013, p. 2138). The qualitative and quantitative methods are selected based on the research questions and feasibility (Fetters et al., 2013). In this study, an education and exercise intervention was chosen to understand the effects of education and supervised exercise on physical function, blood pressure, fasting blood glucose levels, and anthropometric measures in people with T2D. One-on-one telephone interviews were conducted to understand motivation to continue exercise one-month, six-months, and 12-months after completing the GFAL-D program.

The GFAL-D program was developed by the CCAA. The GFAL-D, an eight-week supervised education and exercise program, was provided free of charge to study participants. The GFAL-D is an adaptation from the "Get Fit for Active Living", an eight-week supervised education and exercise program designed to improve exercise participation in community-dwelling older adults (Stathokostas et al., 2017). I was

running both the education and exercise sessions at the CCAA. I became certified as both a GFAL-D instructor and Senior Fitness Instructor by the CCAA, which were both requirements for running the program at the CCAA. I conducted the GFAL-D program three times from September 2018 to November 2019. The intervention took place on Tuesdays and Thursdays. Tuesdays consisted of a one-hour education session and one-hour exercise session and Thursdays consisted of a one-hour exercise session. The education sessions took place in a room at the CCAA with access to a projector to present a slideshow presentation to study participants and the exercise sessions took place in the gymnasium with access to various exercise equipment (e.g., ankle weights, dumbbells, exercise balls).

Participants received a free copy of the GFAL-D manual, which was developed by the CCAA, that contained information discussed during the education sessions. The education sessions addressed the following topics: exercise adherence with information on the transtheoretical model of behaviour change; cardiorespiratory exercise; muscle strength and endurance exercise; stretching, flexibility and balance; healthy eating; disease prevention; exercising at home and exercise program options. In addition to the standardized GFAL-D program, we introduced the free mobile health application, MyFitnessPal™ (https://www.myfitnesspal.com/) to study participants throughout the education sessions and participants were encouraged to use the application during the intervention and after completing the GFAL-D program. Participants were instructed on how to download, navigate, and use the application to log daily exercise and nutrition. Weekly check-ins and individual hands-on assistance were provided throughout the

course of the GFAL-D intervention to provide support to individuals with using the application.

The supervised exercise sessions consisted of a five-minute dynamic warm up, 20 minutes of cardiorespiratory exercise, 20 minutes of strength training, 10 minutes of balance exercises and a five-minute static cool down. The five-minute warm up consisting of walking around the perimeter of the gymnasium combined with dynamic range of motion movements of the six major joints (shoulder, elbow, wrist, hip, knee, ankle). Cardiorespiratory exercise consisted of brisk walking (either walking around the perimeter of the gymnasium or across the gymnasium) while performing upper extremity exercises with 1–2-pound dumbbells or step aerobics using 8-inch plastic risers. Participants checked their heart rate at 10 minutes and 20 minutes using the radial or carotid artery to ensure they were working at the target heart rate zone of 65-60% age-predicted maximum heart rate. Strength training consisted of two sets of eight to 12 repetitions with the aim of reaching 3-5 on the Rating of Perceived Exertion (RPE) (Borg, 1982) using dumbbells, resistance bands, ankle weights, and bodyweight. Eight exercises consisting of compound (i.e., multi-muscle, multi-joint) and single-joint exercises were performed during each session targeting the major muscle groups (i.e., biceps, triceps, deltoids, pectorals, trapezius, erector spinae, abdominals, quadriceps, hamstrings, gluteals, adductors, abductors, gastrocnemius, and tibialis anterior). Muscular endurance exercises for the erector spinae and abdominals included the forearm plank with feet together (Park & Park, 2019) and bird-dog (Calatayud et al., 2019) and were completed in two sets of 15-20 repetitions or 20-second holds. Static and dynamic balance exercises were performed as able and progressed by decreasing the

base of support (e.g., standing feet together, tandem standing, standing on one foot) (Berg et al., 1992). The five-minute cool down consisted of a series of static stretches for the major muscle groups (e.g., wall chest stretch, rear deltoid stretch, seated single leg hamstring stretch, wall supported standing quadriceps stretch, standing side lunge stretch).

Prior to participating in the GFAL-D program, study participants completed a background questionnaire (see Appendix N), which collected information on sex or gender, age, years since T2D diagnosis, current medications, diabetes complications, other co-morbid conditions, employment status, highest level of education, and marital status. Participants also completed the Behavioural Regulation in Exercise Questionnaire – Version 2 (BREQ-2) pre- and post-GFAL-D (Markland & Tobin, 2004). The BREQ-2 is a 19-item questionnaire that assesses amotivation, external, introjected, identified and intrinsic motivation towards exercise (Markland & Tobin, 2004).

I measured each participant's waist circumference using the halfway point between the ribcage and superior iliac crest (Ross et al., 2020), height, and mass to calculate BMI pre- and post-GFAL-D. Participants recorded their morning fasting blood glucose reading using their personal glucometer on the day of pre- and post-GFAL-D assessments, which I recorded. To measure blood pressure pre- and post-GFAL-D, participants rested in a chair for five minutes and then blood pressure was measured three times, following standard rest intervals, using a portable automatic BP monitor (Omron modelHEM-711ACCAN, Burlington, ON) (Chobanian et al, 2003). I then calculated and recorded the average blood pressure of the three measures (Chobanian et al, 2003).

I then measured physical function for each participant pre- and post-GFAL-D using the following clinical outcome measures in this same order on both occasions: the 6MWT, TUG test, 30-second CST, arm curl test, sit-and-reach test, and the back-scratch test. For the 6MWT, participants were instructed to walk at a self-selected pace for six-minutes, timed continuously using a stopwatch, around a rectangular perimeter of the gymnasium marked by pilons, taking breaks as needed. Walking slightly behind the participant, I used a rolling meter stick (Measure Master modelMM-12m, Rolatape, Spokane, WA) to record total distance walked in six-minutes (American Thoracic Society, 2002). For the TUG test, study participants were seated in a standard armchair in the 'start' position with their back against the chair, forearms resting on the arms of the chair. On the command 'go', participants were instructed to stand up and walk at a comfortable and safe pace to a line on the floor three meters from the chair, turn and return to the chair to sit down. Time in seconds from the word 'go' to return to sitting in the chair with their back touching the chair back was recorded (Podsiadlo & Richardson, 1991). Study participants performed one practice TUG and one timed trial.

One trial each of the 30-second CST and the arm curl test was completed. For the 30-second CST, study participants were seated in a standard armchair with their back against the chair. I instructed participants to stand up as quickly as possible to a full stand position and sit back down in the chair. I recorded the number of sit-to-stand movements completed in 30 seconds (Jones et al., 1999). To perform the arm curl test, participants were seated in an armless chair with their back supported using the arm of their choosing. I instructed study participants to perform as many bicep curls as they could in 30 seconds with proper form. Females used a five-pound dumbbell and males

used an eight-pound dumbbell. The number of bicep curls was reported (Rikli & Jones, 1999).

For the sit-and-reach test, study participants sat on the front edge of an armless chair extending the leg of their choosing and flexing the foot to rest the heel on the floor. Study participants extended the same arm as the extended leg and reached as far forward as possible to the toes of their extended leg. The distance (cm) from the tip of the third digit to the anterior surface of the great toe was measured and recorded using a ruler (Rikli & Jones, 1999). For the back-scratch test, participants reached behind their head with one arm and behind their back with the other arm. Using a ruler, the distance between tips of the third digits was measured and recorded using a ruler (Rikli & Jones, 1999).

We conducted one-on-one telephone interviews one-, six-, and 12-months post-GFAL-D to explore motivation to continue exercise after completing a supervised education and exercise program. Interviews were semi-structured (see Appendix O) and were conducted between December 2018 and November 2020. Study participants began sharing their experience being diagnosed with T2D and then described motivators and barriers to exercise, what types of exercise or physical activity they were doing, periods of discontinuing exercise, and self-management strategies. Throughout the interviews in all three studies, we played an active role in data generation through creating meaningful interpretations as well as influencing participant responses through open dialogue (Bradshaw et al., 2017).

2.3.3 Data Analysis

Completed online Qualtrics®[XM] surveys from study one was downloaded to Microsoft Excel 365 (St. Redmond, WA) and summarized using descriptive statistics in a table. BREQ-2 questionnaires from study three were scored and described textually. Fasting blood glucose, blood pressure, anthropometrics, and physical function measures from study three were summarized and presented for each study participant separately (Mathes & Pieper, 2017). Outcome measures pre- and post-GFAL-D were compared to the minimally clinically important difference (MCID) supported by the literature as calculating statistical significance does not align with a case series study (Mathes & Pieper, 2017).

Interviews from all three studies were audio recorded using my cell phone and transcribed verbatim by myself. Thematic analysis was used to analyze interview transcripts proposed by Braun and Clarke (2006). Thematic analysis is a common technique for data analysis in qualitative descriptive research (Doyle et al., 2020). Transcripts were read and re-read to become familiar with the data (Braun & Clarke, 2006). I performed initial coding, which was descriptive and interpretive, from interview transcripts, which were frequently used or significant words or phrases from the interviews (Braun & Clarke, 2006/2012). Initial codes were organized into a coding chart that contained direct quotes from interview transcripts, which was reviewed and edited by my supervisor. I wrote memos directly on the interview transcripts about my general impressions about the interviews, acknowledging how my previous experiences and assumptions as a physiotherapist influenced how I interpreted the data (see Appendix J) (Finlay, 2002). Dr. Denise Connelly and I met regularly during the data collection and analysis process to discuss the development of the initial codes and themes. For study

three in particular, the ICCC and HCAB models were used to help identify codes by identifying individuals involved in T2D care as well as financial, structural and cognitive barriers to accessing physiotherapy (Carrillo et al., 2011; Nuño et al., 2012). Dr. Denise Connelly and I used an inductive approach to the data analysis and identified patterns in participants' experiences individually first (Braun & Clarke, 2006/2012). We then met to compare identified patterns, sorting the patterns and participants' experiences into themes, and chose representative quotations for the themes, ensuring that the themes remained close to the data (Braun & Clarke, 2006; Doyle et al., 2020).

Data collection and analysis were conducted concurrently. This allowed for the interview guides to be modified based on the analysis, to allow for a deeper understanding and further development of the emerging themes (Green et al., 2007). For study two, second interviews were required to seek clarification on emerging themes and provided an opportunity for member reflections (Charmaz, 2014). No new themes emerged from the second interviews but rather provided more context to the existing themes. Data collection stopped when no new codes were being generated from the interviews.

2.3.4 Ethics Approval

All studies were approved by the University of Western Ontario Health Sciences Research Ethics Board (HSREB) (see Appendix A, G, and K). Letters of information and consent were provided to all participants that described the nature of the research, what will be asked of study participants, benefits/risks, how data will be reported and stored, and confidentiality of personal health information. All study participants were informed that participation was voluntary, and they were able to withdraw at any time without

penalty. In the letter of information and consent, study participants also provided consent to allow interviews to be audio-recorded, with all identifying information removed.

Written informed consent, by providing a signature after reading through the letter of information and consent and by asking any questions they had was required for participation for studies two and three. Informed consent for study one was provided by clicking a 'consent button' before beginning the online survey. All forms of anonymization and storage, including de-identification, encryption, and password protection, were completed in compliance with the HSREB requirements.

2.4 Quality Criteria

To ensure quality qualitative research, Tracy's (2010) eight "Big-Tent" criteria for excellent qualitative research were considered and attended to when conducting and analyzing the three studies presented in my dissertation. Tracy (2010) states that "good qualitative research is relevant, timely, significant, interesting, or evocative" (p. 840) and that "worthy topics often emerge from disciplinary priorities and, therefore, are theoretically or conceptually compelling" (p. 840). The three studies presented in this dissertation are considered a worthy topic according to Tracy (2010), as the prevalence of T2D continues to grow throughout the world (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), despite the implementation of diabetes education centers. The purpose of these studies was to increase the awareness of the potential impact physiotherapists could play in T2D management.

Tracy's (2010) definition of significant contribution asks the questions, "Does this study extend knowledge? Improve practice? Generate ongoing research? Liberate or empower?" (p. 845). In particular, the survey study conducted by Doehring et al. (2016)

called for a review of the entry-to-practice physiotherapy training pertaining to T2D knowledge, as physiotherapists surveyed lacked confidence counseling patients with T2D. To extend knowledge, we sought to explore T2D content in entry-to-practice physiotherapy programs across Canada in study one. This dissertation aims to highlight a knowledge-to-practice gap between the potential impact of physiotherapists and how T2D is currently being managed and therefore, we believe these studies represent practically significant research (Tracy, 2010). Additionally, the three studies have the potential to generate ongoing research regarding the feasibility of incorporating physiotherapists into T2D management and should focus on health care costs, hospital stays and resources, and patient satisfaction.

According to Tracy (2010), "resonance can be achieved through aesthetic merit, evocative writing, and formal generalizations as well as transferability" (p. 844). To enhance resonance, I believe the studies presented in my dissertation tell a coherent story on what T2D knowledge is taught in entry-to-practice physiotherapy programs, how physiotherapists view incorporation of T2D into caseloads, and assessing the implementation of physiotherapist-led group exercise as a treatment opportunity. "Resonance also emerges through a study's potential to be valuable across a variety of contexts or situations" (Tracy, 2010, p. 845). To ensure transferability throughout the studies presented in my dissertation, physiotherapists were asked to describe their experiences treating patients with chronic health conditions and what chronic health conditions they saw in their practice (study two). Dean et al. (2016) discussed the importance of incorporation of physiotherapists into management of noncommunicable diseases including T2D, heart disease, smoking-related chronic obstructive lung disease,

hypertension, stroke, obesity, and some types of cancer. My dissertation may shed light on the potential for physiotherapy case load expansion for other noncommunicable diseases, where exercise education, participation and encouragement of behaviour change can make a significant impact.

Rich rigor, defined by Tracy (2010), is when the researchers use sufficient and appropriate theoretical constructs, samples, contexts, data collection and analysis processes, and time in the field. The three studies included educators, practicing physiotherapists, and patients with T2D, capturing a complex picture of exercise and physiotherapy for T2D management.

> In terms of interviewing, demonstrations of rigor include the number and length of interviews, the appropriateness and breadth of the interview sample given the goals of the study, the types of questions asked, the level of transcription detail, the practices taken to ensure transcript accuracy, and the resultant number of pages of interview transcripts (Tracy, 2010, p. 841).

To ensure rigor throughout the interview process, study one involved second interviews, with a new set of questions, to expand on participants' perspectives and further define the emerging themes. Study three involved interviewing participants over a one-year period at one-, six-, and 12-months post-GFAL-D. Although an interview guide was developed for each study, probing questions were unique to each participant given their responses to questions. As well, the interview guide was adapted prior to subsequent interviews to allow for a deeper understanding of the emerging themes. The interview questions remained in alignment with the goals of the studies. Additionally, A figure for

each of the three studies was developed containing the initial codes that generated each theme.

Sincerity is "achieved through self-reflexivity, vulnerability, honesty, transparency, and data auditing" (Tracy, 2010, p. 841). When practicing self-reflexivity, Tracy (2010) recommends asking "why am I doing this study?", "why now?", and "am I ready for this?" (p. 842). I hope to have addressed how my previous experiences, assumptions, and goals for conducting this research influenced the research process in the following section "Statement of reflexivity". The studies presented in Chapters three, four, and five are written in first-person to portray to readers my presence and influence throughout the research (Tracy, 2010).

Tracy (2010) defines credibility as "trustworthiness, verisimilitude, and plausibility of the research findings" (p. 842). Credibility takes into consideration thick description, triangulation, and multivocality (Tracy, 2010). Thick description refers to providing sufficient detail to allow readers to come to their own conclusions about the researchers' interpretations of the findings (Tracy, 2010). The goal of thick description in qualitative research is to show the reader rather than tell the reader what to think (Tracy, 2010). Thick description was considered when choosing which direct quotations to incorporate into the findings. We chose quotations that best represented participants' experiences and perspectives to represent the themes. Triangulation refers to using multiple sources of data or types of data, theoretical frameworks, or researchers analyzing and interpreting the data (Tracy, 2010). To enhance credibility, multiple sources of data collection (e.g., surveys, interviews, outcome measures) and frameworks including the ICCC, HCAB and self-determination theory were integrated. For all three

studies, Dr. Denise Connelly and myself analyzed interview transcripts separately and were involved in developing initial codes and defining themes. Lastly, multivocality refers to integrating multiple voices throughout the research, which can be achieved through member reflections (Tracy, 2010). Member reflections involve discussion with "participants about the study's findings, and providing opportunities for questions, critique, feedback, affirmation, and even collaboration" (Tracy, 2010, p. 844). Studies one and three involved multiple interviews with participants to elaborate on experiences and seek feedback on emerging themes.

Ethical practice considers our actions towards participants and colleagues (Tracy, 2010). Procedural ethics refers to seeking approval from a governing body to conduct research. All studies presented in my dissertation were approved by HSREB and adhered to all safety, privacy, and confidentiality protocols. Situational ethics "assumes that each circumstance is different and that researchers must repeatedly reflect on, critique, and question their ethical decisions" (Tracy, 2010, p. 847). For example, our original protocol for study one asked participants to share course materials. However, one participant mentioned that they did not feel comfortable sharing this information and after reflection on the purpose of this form of data collection, we decided to exclude this form of data collection. Instead, participants elaborated on what and how T2D was integrated into the course(s) they teach. For example, one participant detailed that T2D is incorporated into the final exam through a case study where students must integrate the exercise and physical activity guidelines.

Lastly, meaningful coherence refers to research that "eloquently interconnect[s] their research design, data collection, and analysis with their theoretical framework and

situational goals" (Tracy, 2010, p. 848). Meaningfully coherent studies achieve the purpose of the study and use methods that align with the researcher's paradigmatic lens (Tracy, 2010). One example of how we achieved meaningful coherence is with the use of member reflections in studies one and three. Member reflections allowed for engagement of the findings with participants, aligning well with a qualitative descriptive methodology where participants and researchers would agree on the interpretations of the findings (Sandelowski, 2000). Meaningful coherence is achieved when the "study hangs together well," where the purpose statement, findings, conclusions and supporting literature interconnect and tell an articulate story (Tracy, 2010, p. 848). In addition to having clearly defined research questions with conclusions and clinical implications drawn from the findings, one example of interconnecting the supporting literature is referencing Doehring et al. (2016). Doehring et al. (2016) reported lack of confidence providing T2D education to patients with T2D and called for further research regarding T2D content in entry-to-practice physiotherapy programs.

2.5 Statement of Reflexivity

It is important to recognize my influence throughout the research process, continually evaluating "subjective responses, intersubjective dynamics, and the research process itself" (Finlay, 2002, p. 532), becoming consciously self-aware of how my previous experiences, assumptions, and values shaped the decision-making process throughout conducting my research (Finlay, 2002). Prior to entering the combined Master of Physical Therapy – Doctor of Philosophy (MPT-PhD) program, I had no experience in qualitative research. However, I did have an interest in exercise science. My undergraduate degree was in human kinetics with a minor in nutritional and

nutraceutical sciences. Having taken numerous courses on human metabolism, I continued my education and completed a Master of Science in Pharmacy, where I studied metabolic pathways involved in regulating pancreatic beta cell insulin secretion in an animal model. I was fascinated with the complexity of T2D and given the high prevalence and having a family history of T2D, I wanted to continue studying T2D albeit from an exercise science and health promotion perspective.

I was accepted to the combined MPT-PhD program, as I wanted to somehow connect the profession of physiotherapy with T2D. My understandings of how physiotherapy could be a management strategy for people living with T2D changed throughout the past five years through discussions with Dr. Denise Connelly, committee members, clinical instructors and faculty members in the MPT program, participants, and journaling.

Study three commenced prior to starting the MPT program and ethics for study one was approved before the MPT program, but data collection continued throughout the completion of the MPT program. As my knowledge surrounding physiotherapy grew immensely through clinical education and training over the two years, my presuppositions on the role of physiotherapy for T2D evolved, resulting in new research questions, interview questions, frameworks utilized, and the development of study two.

Participants for study one discussed clinical reasoning, placement opportunities, and case-based learning, concepts that were still foreign to me at the time as a new MPT student. This required further probing questions and asking participants to elaborate. I felt more familiar with the concepts and terminology used during the second interviews after having completed one year of the MPT program. Study two was designed prior to

my first clinical placement, which was in the general medicine unit in an acute care setting. My previous experiences and early course work in the MPT program led me to believe T2D was a highly prevalent condition among patients staying in hospital. I also assumed physiotherapists working in acute care could have the greatest impact on this patient population. However, after completing my first placement, I learned the goals for physiotherapy in an acute care setting are to improve/maintain mobility and function to help get patients back into the community or another residence, with a focus on discharge planning. The caseload for physiotherapy in acute care is large and may not be the most appropriate or effective setting for extensive education or exercise prescriptions for T2D management. These thoughts were reiterated by study participants completing study two, which noted barriers for T2D management by physiotherapists in acute care without probing.

Aside from the physiotherapy aspect of my research, I was not well versed in qualitative research prior to conducting this research with my previous research experience being quantitative. My understanding of the paradigmatic underpinnings and methodology of this research became clearer throughout my studies. Throughout the program, I completed courses on qualitative research methods and became a teaching assistant twice for qualitative research methods in the Health and Rehabilitation Sciences Graduate Program, which provided me with foundational knowledge. Through discussions with the course instructor, students, and coursework, I was able to situate myself in a paradigm and reflect on how knowledge comes to be from my personal perspective.

Prior to conducting these three studies, I had my own assumptions that I needed to reflexively consider. For study one, I assumed that T2D content needed to be presented in lecture format for it to be effectively taught to students. This assumption stemmed from my experience as an undergraduate student and a master's student who extensively studied the pathophysiology of T2D. However, the pedagogy for the professional physiotherapy program emphasizes case-based learning and participants brought to light the logistics of adding content in an already full curriculum, one that must meet accreditation requirements. Prior to conducting study two, I anticipated that participants would not have experience treating patients with T2D as their primary condition of referral, citing lack of confidence and knowledge as the primary reasons. When exploring the motivation towards exercise continuation in people with T2D after having completed a group exercise program, I assumed throughout the one year that individuals would experience relapses with exercise. Although my prior assumptions were similar to what some participants shared in the interviews, I recognize that there were a wide range of experiences and perspectives in these research studies.

When conversing with participants, I ensured that my assumptions did not withhold participants from sharing their thoughts, beliefs, and perspectives. My goal for these studies was to provide an interpretation for a role for physiotherapy for T2D management through the lens of educators, physiotherapists, and people living with T2D. Although the findings are my interpretations, themes and concepts emerged that were different from my assumptions. In particular, the theme *lifestyle management* in study three explored how people living with T2D focused on nutrition to manage their T2D. As a physiotherapy student and someone who has studied metabolic pathways in relation

to T2D, nutrition and exercise are both key components in the regulation of blood glucose levels and important self-management strategies.

When interacting with participants, I needed to consider what information to share about myself. Specifically, as a physiotherapy student, I was interviewing clinical instructors and physiotherapists. I considered whether to reveal myself as a physiotherapy student to participants in studies one and two. Early in the interview process, I decided to reveal myself as a physiotherapy student in the combined MPT-PhD program. Once participants discovered I was a physiotherapy student, they became more open to using specific terminology and discussing physiotherapy practices. I believe that revealing myself to study participants was advantageous, helping to build rapport and perhaps led to richer descriptions of experiences.

My ontological and epistemological position at the beginning of my research until now has greatly evolved. After completing coursework in qualitative research methods in the beginning, I was still unsure which paradigm resonated with me, as pragmatism was not discussed as often or in-depth as post-positivism, constructivism, and critical theory. It was through discussions and suggested literature by the course instructor, my supervisor, and my own research where I came to know and appreciate pragmatism. Although it wasn't until my engagement with participants and through the data collection and analysis where I truly understood the concept of transactional realism. It was then that I recognized how my beliefs and prior knowledge influenced my interpretations of participants' experiences. My goal from conducting this research is to transfer this knowledge to patient care; actively listening to patients' experiences, addressing risk factors for noncommunicable diseases, and promoting overall health and

wellness. My aim is to present evidence that physiotherapists may be an intervention to support people with T2D to manage their chronic health condition.

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Chapter 3

Educators' perspectives on the teaching and learning of type 2 diabetes content in physiotherapy programmes across Canada[1]

3.1 Introduction

Diabetes affected 3.4 million Canadians in 2015 with the prevalence expected to increase to 5 million by 2025 (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). T2D, consisting of 90% of all diabetes cases, is characterized by hyperglycemia due to impaired insulin secretion or action (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). People living with T2D are at risk of microvascular and macrovascular complications including peripheral neuropathy, retinopathy, nephropathy, cardiovascular disease, and stroke (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; Zheng et al., 2018). Poorly controlled diabetes is the leading cause of non-traumatic lower limb amputations and cardiovascular disease in Canada (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). Healthcare professionals including physicians, nurses, and dieticians are trained to provide T2D care consisting of lifestyle counselling, medication adherence, and self-monitoring techniques (Blackberry et al., 2013). Counselling interventions (compared to usual care) have shown significant reductions in A1C (Jutterström et al., 2016; Odnoletkova et al., 2016), but they do not address the decreased fitness and mobility in this population that can lead to disability, mortality, and a loss of

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independence (de Rekeneire & Volpato, 2015). A prospective observational study reported an inverse relationship between aerobic fitness and risk of all-cause mortality in 1,263 men with T2D (Wei et al., 2000). Compared to active men, sedentary men were at a 2.1-fold increased risk of all-cause mortality (Wei et al., 2000). However, each metabolic equivalent of tasks resulted in a 25% reduction in all-cause mortality ($p < 0.001$) (Wei et al., 2000). As well, an RCT reported improved TUG scores ($p = 0.032$); ankle muscle strength ($p = 0.031$); and knee range of motion ($p = 0.001$) after 143 participants with diabetic peripheral neuropathy completed a two-month physiotherapy-led strength and balance home exercise programme compared to standard medical care (Venkataraman et al., 2019). Therefore, the literature suggests there is a role for physiotherapists in the management of T2D through exercise prescription.

A recent systematic review exploring the role of a multidisciplinary team in managing T2D identified a gap in shared roles and suggested incorporating physiotherapists as a primary healthcare professional (Sani Dankoly et al., 2020). Physiotherapists can contribute to the management of T2D through patient education, and the prescription and supervision of safe exercise. A 12-week community education and exercise programme for 36 adults with T2D that was supervised by a physiotherapist reported clinically significant improvements in the 6MWT (mean difference = 87 m; $p \leq 0.01$) and waist circumference (mean difference = −3 cm; $p \leq 0.05$) (Higgs et al., 2016). As well, no intervention-related adverse events occurred, highlighting that supervised exercise is safe for people with T2D and physiotherapy-led exercise programmes can lead to improvements in function and mobility (Higgs et al., 2016).

Physiotherapists have the education and skill to treat patients with noncommunicable diseases, such as T2D, as the primary condition of referral through early non-pharmacological management in a wholistic, individualized care approach (Dean et al., 2016; Lein et al., 2017). Furthermore, a meta-analysis reported lifestyle modification through nutrition and exercise was the first line of defense for the prevention of T2D in high-risk individuals, with an odds ratio (OR) of 0.65 for developing T2D in the lifestyle group compared to standard care (95% CI: 0.56, 0.75) (Yamaoka et al., 2019). Exercise alone was also effective in preventing T2D compared to standard education interventions with an OR of 0.45 (95% CI: 0.24, 0.84) (Yamaoka et al., 2019).

The Canadian Council of Physiotherapy University Programs (CCPUP) classifies T2D as a level 1 metabolic condition, meaning entry-to-practice physiotherapists are expected to be knowledgeable about the aetiology, pathophysiology, clinical presentation, differential diagnoses, prognosis, medical or surgical management, and physiotherapy interventions for T2D (CCPUP, 2019). However, it is unknown how T2D content is currently being taught in entry-to-practice physiotherapy programs in Canada.

A survey study explored the beliefs and practices of Canadian physiotherapists in the treatment and management of T2D (Doehring et al., 2016). Physiotherapists were confident with exercise education; however, they lacked confidence in providing education on secondary prevention, weight management, blood glucose control, and nutrition (Doehring et al., 2016). Only 32.4% of the 401 physiotherapists who participated in the study provided T2D counselling (Doehring et al., 2016). Furthermore, a recent survey study on physical activity and exercise counselling among

physiotherapists in Nova Scotia reported that physiotherapists are most comfortable providing counselling for patients with musculoskeletal (MSK) injuries and least comfortable for other conditions including T2D (O'Brien et al., 2020).

Research suggests physiotherapists can play a valuable role in the management of T2D through patient education, monitoring patient outcomes, and the prescription and supervision of safe exercise. However, despite T2D being a level 1 metabolic condition according to CCPUP, practicing physiotherapists are not confident in providing specific education and exercise prescription for their patients with T2D. To begin to address the gap between the expectations of physiotherapists and their knowledge of T2D, we sought to explore and describe the approaches to the teaching and learning of T2D content in the entry-to-practice physiotherapy programs across Canada.

3.2 Methods

We employed a qualitative descriptive design using an online survey and one-on-one semi-structured telephone interviews (Doyle et al., 2020; Sandelowski, 2010). Email notification of an online survey in English was sent to the Programme Chairs of Canadian physiotherapy programmes (n = 15) with a request to distribute the survey link to the faculty or clinical instructor responsible for teaching T2D content in the curriculum or who were knowledgeable about it. Western University's Health Science Research Ethics Board approved the study. Providing consent to the online letter of information and consent triggered access to the survey. On completion of the survey, the respondents were asked to provide email contact information indicating permission to be contacted for a telephone interview.

3.2.1 Data Collection

Online survey

We designed a 24-item online Qualtrics®[XM] (Qualtrics 2019, Provo, UT) survey to explore educators' experience with teaching T2D in the academic curriculum and their perspective on student preparedness for entry-to-practice. As a guide, we used an online survey designed by Bramley et al. (2018) addressing motor learning content in physiotherapy curriculum. We then created questions addressing T2D curriculum, educator opinions of the importance of teaching T2D, confidence teaching T2D content, and preparedness of students for assessment and treatment of people living with T2D. The survey included multiple choice, 5-point Likert scale (1 = not confident, 5 = very confident), level of agreement, and open response text-box questions.

Interviews

We conducted one-on-one semi-structured telephone interviews that were audiotaped and transcribed verbatim. The interview guide focused on T2D content in the curriculum, educators' thoughts on T2D in the curriculum, and the role of physiotherapists in the management of T2D. An example of an interview question is: "Tell me about your experience treating patients with T2D." Another example is: "What aspects of T2D do you teach in your course?" We invited all of the respondents to participate in a second interview to deepen our understanding of emerging themes. Examples of second interview questions were: "How do you prioritize T2D in your course?" "What are the skills and behaviours that students need to develop to address primary prevention of T2D?"

3.2.2 Data Analysis

We downloaded the completed online Qualtrics®XM surveys to Microsoft Excel 365 (St. Redmond, WA) and summarized the data using descriptive statistics. Then we read and reread the interview transcripts with the research question guiding what we wanted to know from the data. Thematic analysis was employed to analyze interview transcripts (Braun & Clarke, 2012). We performed initial coding that was both descriptive and interpretive, and collected excerpts from the data for each initial code generated (Braun & Clarke, 2012). Then we grouped similar codes together to generate broader themes and checked the themes against the initial codes to ensure coherency (Braun & Clarke, 2012). We took an inductive approach to data analysis to develop the participant experiences into representational themes (Braun & Clarke, 2006; Charmaz, 2014). We met repeatedly throughout the analysis of the interviews to compare identified patterns and work together to sort the patterns into themes. The meetings included discussion and collaboration in identifying the final themes, naming of the themes, and choosing representative quotations for themes. Throughout the interview analysis, the meetings served to ensure that the generated themes remained close to the data and were not guided by the researchers' interests. It is important to note that the researchers analyzed the transcripts with different perspectives. Two authors are instructors in a master of physiotherapy programme, and the other is a student in a master of physiotherapy programme with an interest in T2D research.

We performed data collection and analysis concurrently, which modified the interview guide to focus on emerging themes. Second interviews allowed an opportunity for member reflections and seeking clarification on emerging themes (Charmaz, 2014;

Tracy, 2010). No new themes emerged from the second interviews. We discussed codes and themes and reached a consensus.

3.3 Results

3.3.1 Online Survey

Ten participants from 10 physiotherapy programmes in Canada's Atlantic, Central, Prairie, and West Coast regions completed the online survey. The respondents represented both English- and French-speaking schools. The participants were those who were assigned to teach T2D content or who served as the Curriculum Committee Chair and were knowledgeable of the physiotherapy profession in Canada. Participant characteristics are summarized in Table 1. Table 2 provides a summary of T2D content and educators' perspectives about T2D in their physiotherapy programme. All participants emphasized the incorporation of problem- or case-based learning in their programmes, with case studies and lecture content the most commonly reported methods of T2D content delivery.

Table 1. Participant characteristics (n = 10).

Characteristic	No. (%)
Highest level of education completed	
Bachelor's	2 (20)
Master's	3 (30)
PhD	5 (50)
Highest level of PT education	
Bachelor's	7 (70)
Master's	3 (30)
Clinical experience (years)	
< 5	1 (10)
5–10	0 (0)
11–15	1 (10)
16–20	3 (30)
> 20	5 (50)
Main area of clinical practice	

Cardiorespiratory	4 (40)
MSK	2 (20)
Geriatric	2 (20)
Sport	1 (10)
Multisystem	1 (10)
Years of teaching experience	
< 1	1 (10)
1–5	3 (30)
6–10	2 (20)
> 10	4 (40)
Position at current institution	
Part-time instructor	2 (20)
Lecturer	3 (30)
Assistant professor	2 (20)
Associate professor	2 (20)
Professor	1 (10)
Main teaching area	
Cardiorespiratory	3 (30)
MSK	2 (20)
Orthopaedic	1 (10)
Geriatric	1 (10)
Chronic disease	1 (10)
Limb loss	1 (10)
Multisystem	1 (10)

MSK = musculoskeletal

Table 2. T2D content and educators' perspectives from the online survey (n = 10).

Question	No. (%) of responses
What year of the PT programme do you teach T2D content? (Select all that apply.)	
1	6 (46)
2	7 (54)
How many total hours of T2D content do you teach?	
< 5	7 (70)
5–10	2 (20)
> 10	1 (10)
What area of T2D do you teach in your course(s)? (Select all that apply.)	
Rehabilitation	7 (29)
Cardiorespiratory	6 (25)
MSK	5 (21)
Neurological	5 (21)

Public health	1 (4)
Which of the following topics do you cover regarding T2D content? (Select all that apply.)	
Exercise	8 (20)
Diabetes complications and comorbidities	8 (20)
Blood glucose control	7 (17)
Physiology	7 (17)
Weight management	6 (15)
Nutrition	3 (7)
Anatomy	2 (5)
Which methods do you use for the delivery of T2D content? (Select all that apply.)	
Case studies	8 (31)
Lecture	7 (27)
Small group discussion	5 (19)
Clinical skills lab	3 (12)
Assignments	1 (4)
Presentations	1 (4)
Problem-based learning	1 (4)
Do you feel that adequate time is devoted to T2D in the PT programme?	
No	6 (60)
Yes	4 (40)
How confident do you feel teaching T2D content to students? (1 = not confident, 5 = very confident)	
1	0 (0)
2	0 (0)
3	1 (10)
4	8 (80)
5	1 (10)
How prepared do you think students are in applying T2D knowledge once they graduate? (1 = not prepared, 5 = very prepared)	
1	0 (0)
2	3 (30)
3	7 (70)
4	0 (0)
5	0 (0)
T2D is an essential component of the PT programme:	
Strongly agree	7 (70)
Agree	2 (20)
Somewhat agree	0 (0)
Neither agree nor disagree	1 (10)
Somewhat disagree	0 (0)
Disagree	0 (0)
Strongly disagree	0 (0)

T2D = type 2 diabetes

T2D was interwoven within the MSK, neurological, and cardiorespiratory areas of physiotherapy curriculum. Nine participants reported that at least two of the following areas of course instruction included T2D-related content in physiotherapy curriculum: MSK, cardiorespiratory, neurological, rehabilitation, and public health.

The main T2D-related topics covered in the programmes were exercise and secondary complications; however, nutrition, weight management, blood glucose control, physiology, and anatomy were also covered. One participant reported that exercise was the only topic discussed when teaching T2D content.

Although educators were confident teaching T2D content, they did not feel students were well-prepared to adequately treat or address T2D as entry-to-practice physiotherapists. Seven of the 10 respondents reported less than five hours of T2D teaching in the curriculum. There were conflicting responses on whether adequate time was spent on T2D in the curriculum, with four of the 10 participants responding “yes,” and six of the 10 responding “no.” However, nine of the 10 participants “strongly agreed” or “agreed” that T2D was an essential condition taught in the curriculum.

3.3.2 Interviews

Seven of the 10 participants completed interviews lasting an average of 30 minutes. Of the seven participants, four had completed a Doctor of Philosophy degree, two had completed a master’s degree, and one had completed a bachelor’s degree as their highest level of education. Four participants were professors, two were full-time lecturers, and one was a part-time instructor. Teaching experience in a physiotherapy programme ranged from under one year to more than 10 years. Four participants taught a

course or courses in cardiorespiratory, and three in MSK. Of these seven, three completed a second interview. We identified four themes relating to T2D content in physiotherapy curricula and perceptions of T2D in the field of physiotherapy held by educators. Figure 1 depicts our four main themes and codes.

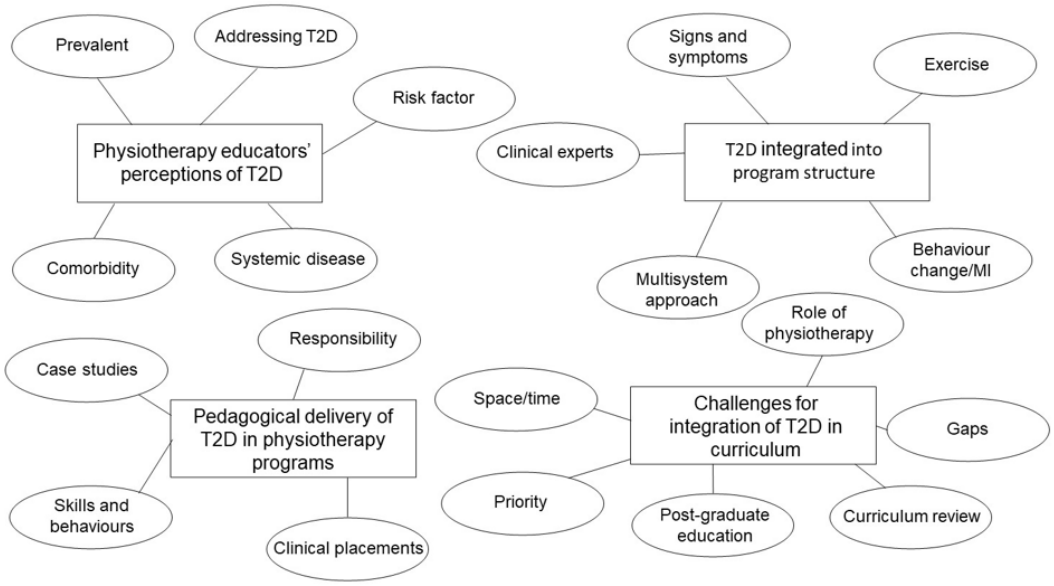

Figure 1. Thematic map showing the four main themes (rectangles) with associated codes (ovals).

Theme one: Physiotherapy educators' perception of T2D

All participants agreed that T2D is a common condition that is seen in all areas of practice. "I imagine that T2D is pretty prevalent in most populations so whether that's in a private MSK clinic or acute-care hospital or rehab clinic" (P4). Participants acknowledged the prevalence of T2D in physiotherapy settings but had varying perceptions of directly treating T2D in physiotherapy interventions. Perceptions could be, in part, related to the area of clinical experience. Two educators with experience in outpatient clinical settings described more time to treat 'the whole' patient including

concerns related to T2D, whereas three educators with experience working in acute-care settings with more complex patients described having less time and a perceived inability to treat T2D if it wasn't the main concern.

Participants often used 'risk factor' and 'comorbidity' to describe T2D, providing insight into where T2D fits in the curriculum. "I mostly talk about [T2D] in cardioresp, obviously as a risk factor" (P6). Participants often described T2D as a comorbidity and not the primary condition for treating patients. "[T2D] was never the focus of my therapy, it would always come as a comorbidity" (P3). Three participants described integrating a wholistic approach to care and addressed T2D when treating patients for other conditions. "You can't just target your shoulder issue without targeting your glycemic control if I want to be a good clinician" (P5).

Theme two: T2D integrated into programme structure

Course coordinators often had guest lecturers with clinical experience working in a specific area of practice. "We hire specialists to go teach … some are physicians … when it comes to assessment, it's mostly PTs who have clinical experience in that domain" (P2).

Physiotherapy programmes were often structured around the core systems of physiotherapy: MSK, neurological, and cardiorespiratory. T2D was often interwoven within different courses as T2D affects multiple systems. "We're talking about what the disease is, we're talking about diabetic medication, and we're then talking about how those help to manage the disease" (P7). Six educators taught T2D content from the perspective of the core physiotherapy systems. "We talk about neuropathy but not all the other systems that can be involved" (P6). However, the teaching of T2D in all pillars of

physiotherapy was essential. “Until the students have education in all of the three main pillars of PT, they may not have a good enough understanding to really tackle the complexity of caring for people with diabetes” (P7). Only P5 and P7 described integrating T2D into the three core systems. In addition, three participants stated that students received education on wound and foot care. “We spend a reasonable amount of time on diabetic foot ulcers and foot care including a lecture from a pedorthist” (P7). Physiotherapy programmes can provide students with the foundational knowledge to treat patients with T2D, but it may not be fully implemented in the curriculum.

In terms of what T2D topics were taught in the curriculum, educators focused on the students’ ability to recognize the clinical presentation and exercise prescription. “We try to teach them to recognize the signs and symptoms of hypoglycemia and neurological changes, vascular changes” (P2). More emphasis was the assessment of patients with T2D compared to interventions. “The intervention part is much more softer” (P2).

Aside from courses containing T2D content, participants discussed the concepts of behaviour change and how these strategies can be implemented when treating patients with T2D. “We have [students] identify facilitators and barriers and then try to either place them in a category in the transtheoretical model or see which of the behaviour change models might be most appropriate to apply” (P5). However, approaches to behaviour change varied among physiotherapy programmes. “We don’t talk a lot about behavioural components … it’s not a huge component in our curriculum that’s for sure” (P6).

Theme three: Pedagogical delivery of T2D content in physiotherapy programmes

This theme described the delivery methods for T2D content and the knowledge, skills, and behaviours that are essential for physiotherapy practice. Case studies were the primary delivery method for T2D content. “We make [case studies] more realistic to what our patients present with by giving them some of these more common conditions” (P4). However, despite the emphasis on problem- or case-based learning throughout the curriculum, it was noted that students required prompts to identify the ways in which T2D may be impacting the patient presented in the case study when they get to the second-year course, “they seem to be limited in their capacity without being prompted or taught of how diabetes affects things when they get to the second-year course” (P1). Some participants discussed that although case studies are the primary delivery method, deeper learning happens when students are on clinical placements. “Learning with a real-life patient in front of you is so much more valuable than the case studies” (P5). Students’ clinical experiences regarding T2D, in part, depended on the clinical instructor and the responsibility of students taking advantage of learning opportunities on placement. “Sadly, physio students come in with preconceived ideas about where they’d like to work and sometimes don’t make the most of their clinical experiences to really learn as much as they can from that” (P5). All seven educators agreed that students needed to take ownership of their learning experiences when out on placement.

Four educators emphasized the importance of students researching conditions independently. “I think that [students] need to be independent learners … when we don’t know the answer, what do we do? We ask our colleagues, we research” (P6). One participant acknowledged the educators’ responsibilities when it comes to teaching. “I think it’s on the instructors to help light the fire in the students that it’s not a chore …

they're going to go home and say, that was kind of cool what we talked about today, I want to find out more about that" (P1).

Educators commented on the required skills that cannot be taught in lecture. "I think listening to their patients" (P6). "It's the art of communication. If they came to you for plantar fasciitis, and now, you're giving them a lecture on shedding a few pounds. Like, there's an art to that" (P1).

Theme four: Challenges for integrating T2D content in the curriculum

Participants addressed the gaps in the physiotherapy curriculum regarding T2D content. "It's not a huge focus as a condition on its own … we don't perhaps highlight it as much as we need to" (P4). Lack of time in an already full curriculum was also noted. "If I had more time and more resources maybe I would bring diabetes back to the normal schedule instead of just being included in the exam" (P3).

Despite an already overcrowded curriculum, T2D knowledge was considered essential for physiotherapy programmes, and educators acknowledge the impact physiotherapists can have on patients with T2D as a primary condition of referral:

> If they are just diagnosed and they need some coaching and self-management assistance with optimizing exercise … be screened for complications … or if they're living with a complication … there's lots of good reasons where a person with diabetes could be referred to a physiotherapist (P5).

More broadly speaking, the role of physiotherapists from a general health promotion standpoint that can have an influence on patients with T2D was emphasized. "Empowering the merits of an active lifestyle and mobility and general fitness and

cardiovascular fitness … I think, my role as a physiotherapist, that's how I see where we make our biggest impact" (P1). Although T2D content and perceptions of its importance differed among participants, five of the seven participants agreed that physiotherapists should assume a larger role in the management of T2D.

3.4 Discussion

This study described the approaches to teaching and learning of T2D content in the entry-to-practice physiotherapy programmes across Canada. In a survey of Canadian physiotherapy programmes, we gathered data regarding the timing, quantity, and aspects of T2D content in academic curricula from 10 of the 15 physiotherapy programmes. Previous studies explored physiotherapists' experiences with prescribing safe exercise for T2D management (Higgs et al., 2016) and their perceived confidence in treating patients with T2D (Doehring et al., 2016). Knowing the high prevalence of T2D in the general population, and the growing need for the physiotherapy profession to evolve as primary care providers as the population ages and the prevalence of chronic health conditions increases (Nicholls, 2020), it is important to understand the level of information and training included in the physiotherapy curriculum to align with this need for healthcare services.

The National Physiotherapy Entry-to-Practice Curriculum Guidelines (2019) developed by CCPUP, the Canadian Alliance of Physiotherapy Regulators, and the Physiotherapy Education Accreditation Canada classifies T2D as a key indicator health condition that is prevalent among patients seen by physiotherapists working in cardiovascular-pulmonary, MSK, neurological, and other areas of physiotherapy practice (CCPUP, 2019). Although most programmes taught T2D from a multisystem perspective

and covered a number of topics pertaining to lifestyle management, six of the 10 educators reported that not enough time is devoted to T2D content, and all educators believed students could better be prepared to treat T2D as entry-to-practice physiotherapists. This may be due to the level of awareness of T2D content in other courses in the curriculum among educators or how educators prioritize T2D compared to other conditions required to be taught in the programme. As well, T2D affects multiple body systems and leads to numerous complications. A lack of integration of T2D content throughout the core physiotherapy systems may contribute to educators' responses in the survey pertaining to a lack of student preparedness on entry-to-practice. One potential solution that a participant presented was postgraduate training or education on T2D; however, the effectiveness of and interest in a continuing education course should be considered.

Theme one explored educators' perspectives on the prioritization of T2D in physiotherapy interventions. Participants agreed that T2D was highly prevalent; 80% of patients in outpatient PT settings have T2D or are at high risk of developing T2D (Kirkness et al., 2008). Often, particularly in acute care settings, T2D is classified as a comorbidity and not addressed by physiotherapists. Although one participant discussed taking a wholistic approach to care, this was not the norm. A mixed methods study of primary healthcare professionals including physiotherapists explored the effect of an intense lifestyle intervention consisting of motivational interviewing, and a physical activity and nutrition diary (Linmans et al., 2015). Apart from significant improvements in physical activity levels ($p = 0.027$), weight loss ($p = 0.031$) and A1C ($p = 0.012$), patients with T2D reported consultations with a physiotherapist and tracking physical

activity through a diary useful (Linmans et al., 2015). Our findings suggest that there may be a missed opportunity for physiotherapists in the management of T2D in Canadian physiotherapy practice.

Theme two described integrating T2D content into physiotherapy curriculum, focusing on comprehension of the three pillars of physiotherapy: MSK, cardiorespiratory, and neurology. Additionally, T2D content was presented during the teaching of behaviour change, which varied across physiotherapy programmes. However, the CCPUP includes implementation of behaviour change strategies for patient-centered care (CCPUP, 2019). A content analysis of physical activity and exercise promotion across five undergraduate physiotherapy programmes also reported a lack of education or training on approaches for adopting physical activity and exercise into daily life for non-communicable diseases including obesity and T2D (O'Donoghue et al., 2011).

In theme three, educators emphasized problem- or case-based learning and clinical placement opportunities as the primary methods for learning about T2D. A mixed methods study examined evidence-based practice through lecture- or problem-based learning in 109 physiotherapy students (Lennon et al., 2019). Evidence-based practice, which is part of the essential competencies (CCPUP, 2019), was best taught through problem-based learning, and students reported better understanding ($p = 0.03$), relevance ($p = 0.02$), and overall satisfaction ($p < 0.001$) compared to lecture-based learning (Lennon et al., 2019). However, the authors did not explore specific areas of interest; therefore, it is difficult to suggest that these findings would correlate with better comprehension of T2D content through problem- or case-based learning only. A

qualitative study of a 12-week exercise and education programme for adults with T2D or at high risk for developing T2D was led by physiotherapy students as a clinical placement (van Bysterveldt et al., 2014). Focus groups and in-depth interviews revealed improved communication skills, building rapport with patients, and consolidation of T2D knowledge (van Bysterveldt et al., 2014). Similarly, participants in the current study acknowledged that richer learning, with T2D in particular, occurs while on clinical placement working with patients with T2D; however, student learning is limited by the clinical instructors' perspectives and knowledge of T2D.

Despite challenges identified in theme four, participants elaborated on the impact physiotherapists can play in the management of T2D. Participants acknowledged the role physiotherapists can play in T2D management through health promotion. A scoping systematic review explored health promotion in physiotherapy practice (Taukobong et al., 2014). In this review, physiotherapists believed that health promotion practices were acceptable during interventions and part of their responsibility (Taukobong et al., 2014). Although physiotherapists were confident in implementing health promotion practices, certain aspects did not always fall within the scope of practice and the patient's expectations and goals (Taukobong et al., 2014). Two of the seven participants in the current study discussed the importance of promoting overall health in patients with T2D. Perhaps a greater emphasis on health promotion would benefit physiotherapy students in managing noncommunicable diseases, as only one participant in the online survey reported a public health course containing T2D content. As exercise specialists, physiotherapists have the knowledge and skills to educate all patients on safe**,** effective exercise to improve overall health and aid in preventing noncommunicable diseases.

Behaviour change strategies and motivational interviewing, as mentioned in theme two, are tools to promote health and can be effective for people with T2D. A meta-analysis revealed six months of motivational interviewing improved self-management strategies and significantly reduced A1C ($p < 0.05$) in patients with T2D (Song et al., 2014). As well, a qualitative study explored how patients with T2D felt about motivational interviewing and the following five themes were generated: nonjudgmental accountability, being heard and responded to as a person, encouragement and empowerment, collaborative action planning and goal setting, and coaching rather than critiquing (Dellasega et al., 2012). With behaviour change approaches incorporated into physiotherapy curriculum (CCPUP, 2019) and accessible postgraduate training (https://opa.on.ca/professional-development/course-listings/entry/81254/), physiotherapists are in a unique position to encourage lifestyle modifications through motivational interviewing for their patients with chronic health conditions, including T2D.

3.4.1 Limitations

This study has limitations. First, it did not represent all 15 physiotherapy programmes across Canada. Only seven of the 15 physiotherapy programmes participated in the telephone interviews; therefore, our results do not represent all physiotherapy programmes. We were only able to recruit one educator from each university so we may not have fully captured T2D content in each physiotherapy programme. It is unclear whether programmes that did not participate had an instructor or faculty member that teaches T2D content or is knowledgeable about T2D in the curriculum. As well, although the analysis was data driven, the researchers remain to

have epistemological values, and the data analysis is one interpretation of the findings (Braun & Clarke, 2012).

3.4.2 Conclusion

This study provides insight into T2D content, student learning, and gaps in the physiotherapy entry-to-practice curriculum in Canada. This study explores educators' perceptions of T2D in physiotherapy practice and the impact physiotherapy interventions can have in T2D management. In accordance with previous literature, educators acknowledged the importance of T2D knowledge, but it was often referred to as a comorbidity and not addressed during physiotherapy intervention. Educators noted the complexity of T2D and often taught T2D content from a multisystem standpoint. Even though nine of the 10 participants "strongly agreed" or "agreed" that T2D was an essential component of the physiotherapy curriculum, most respondents also reported that there was not adequate time devoted to T2D in the curriculum. Lastly, educators reflected on the impact that physiotherapists can have in terms of education, exercise prescription, and general health promotion for people living with T2D. Further research is needed to explore optimal integration of T2D in physiotherapy programmes.

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Chapter 4

Physiotherapists' perspectives on type 2 diabetes as a primary condition for referral to physiotherapy services: A qualitative descriptive study[2]

4.1 Introduction

The prevalence of diabetes is predicted to increase to 5 million by 2025 from the 3.4 million Canadians in 2015, of whom 90% had T2D (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). T2D disproportionately affects people of lower socioeconomic status, including income, food insecurity and level of education, of whom have poorer access to healthcare services (Weisman et al., 2018). Poorly controlled T2D can lead to the development of complications including stroke, cardiovascular disease, retinopathy, nephropathy, and neuropathy (Zheng et al., 2018). T2D, however, can be successfully managed through adoption of healthy lifestyle behaviours, including healthy eating habits, and regular physical activity and exercise (Gulve, 2008).

A knowledge-practice gap relating to the prevention and management of T2D in the profession of physiotherapy has been noted (Dean et al., 2016). Conservative physiotherapy management can help reduce the use of pharmacological and surgical interventions for people with T2D, through prescription and supervision of physical activity and exercise. In addition to physical activity and exercise, a systematic review

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suggested that physiotherapists are qualified to provide general lifestyle counseling including smoking cessation, nutrition, and weight management (Frerichs et al., 2012) to maintain/improve overall health. The incorporation of behaviour change strategies by physiotherapists (Dean et al., 2016) support ongoing healthy lifestyle choices. Physiotherapists are more likely to have longer appointments compared to other clinicians, and therefore, have more opportunity to address lifestyle behaviours (Dean, 2009; Dean, 2009; Dean et al., 2011; Dean et al., 2014).

Effectiveness of physiotherapy in the management of T2D is evidenced by physiotherapy-led exercise programs. One study conducted an eight-week physiotherapy-led education and exercise program for 22 women with T2D (Pariser et al., 2010). The exercise program consisted of twice weekly seated aerobic and resistance training while screening blood glucose and blood pressure prior to exercise participation (Pariser et al., 2010). Statistically significant improvements were reported in 6MWT scores (no walking aid group: 62.6 m [95% CI = 55.7, 69.4]; walking aid group: 54.0 m [95% CI = 36.4, 71.6]) and steps/day (no walking aid group: 1226.8 steps/day [95% CI = 896.3, 1557.3]; walking aid group: 887.8 steps/day [95% CI = 458.4, 1317.2]), suggesting physiotherapy-led programs can improve functional mobility, promoting independence in people with T2D (Leenders et al., 2013; Pariser et al., 2010). An RCT of unsupervised exercise prescription by a physiotherapist, aimed at increasing physical activity levels to more than 160 minutes per week at moderate intensity, showed positive results (Wisse et al., 2010). Statistically significant improvements for BMI ($p = 0.029$) and waist circumference ($p = 0.003$) were reported, however, the authors emphasized

that a supervised exercise intervention appears to be required to increase physical activity in people with T2D (Wisse et al., 2010).

The purpose of this study was to describe physiotherapists' experiences treating patients with T2D and explore physiotherapists' perspectives for the uptake of T2D as a primary condition for referral. Previous physiotherapy-related studies have focused on assessing exercise safety (Higgs et al., 2016; Kluding et al., 2015) and health-related outcomes including BMI, blood glucose, blood pressure, and cholesterol from exercise programs (Alvarez et al., 2016; Lambers et al., 2008; Negri et al., 2010). We explored the role of physiotherapy in the management of T2D, which was informed by the Integrated Care for Chronic Conditions (ICCC) and Health Care Access Barriers (HCAB) frameworks (Carrillo et al., 2011; Nuño et al., 2012). The ICCC framework links informed community partners with a motivated healthcare team to improve health outcomes for people living with chronic health conditions, whereas the HCAB model organizes modifiable healthcare access barriers into financial, structural and cognitive barriers (Carrillo et al., 2011; Nuño et al., 2012). As well, we explored perceived barriers for assessing and treating patients diagnosed with T2D in community or outpatient clinical settings across Canada.

4.2 Methods

We employed a qualitative descriptive study design, as the aim of our research was to convey authentic descriptions of participants' experiences treating patients with T2D and perspectives on the uptake of T2D as a primary condition for referral (Doyle et al., 2020; Neergaard et al., 2009). We align with a pragmatic paradigm whereby our ontology and model of practice is ever changing based on human experience, with an

orientation to solving practical problems and prioritizing the focus on patient outcomes (Frey, 2018). Pragmatism is appreciated for its acknowledgement of practical consequences and inclusion of culture and context (Shaw et al., 2010) as vital components to understand experiences and truths (Weaver, 2018). At a fundamental level, a pragmatic paradigm drives our research approach to inform clinical practice most effectively when it is conducted with a clear orientation to clinical practice (Shaw et al., 2010). In a qualitative descriptive methodology, descriptive validity is achieved when the researcher and participants are in agreement on the depiction of the experience being studied, as both are part of the same social world (Sandelowski, 2000). Given this, it is important to acknowledge our pre-understandings. The first author [SJ] was a physiotherapy student with a research background in T2D and the other authors are physiotherapists and educators in academic physical therapy programs. With the high prevalence of T2D, the authors have experience treating patients with T2D as a co-morbidity and have treated T2D-related complications. However, the authors do not teach T2D-specific content in their courses.

4.2.1 Participants and Recruitment

We employed purposive sampling to recruit physiotherapists that have a shared experience treating patients with T2D (Palinkas et al., 2015). Participants were registered physiotherapists working in community or outpatient clinical settings as we sought to explore an opportunity for physiotherapists as primary care providers for community-dwelling adults diagnosed with T2D. Experiences treating patients with T2D as the primary condition for referral, for diabetes complications (e.g., peripheral neuropathy, amputations), and as a co-morbidity were included, as our aim was to achieve maximum

variation, recruiting participants with a wide range of experiences and perspectives (Doyle et al., 2020; Palinkas et al., 2015).

We sought to recruit participants from each province and territory to understand current practices and perspectives across Canada. Our sample size was guided by the concept of information power proposed by Malterud et al. (2016). For example, a larger sample size was required because the aim of our study was considered broad, study participants had a wide range of experiences, and we applied a cross-case analysis rather than an in-depth analysis from a few selected participants (Malterud et al., 2016).

An invitation to participate written in English was emailed to the following organizations for distribution to their members: The Canadian Physiotherapy Association (CPA), the Orthopedic Division of the CPA, and each provincial and territorial Association and College of physiotherapists in Canada. This study was approved by Western University's Health Sciences Research Ethics Board. Respondents expressed interest by responding to the first author via email. The first author then emailed the letter of information and consent form. Eligible participants provided written consent and returned to the first author. Written consent was obtained prior to conducting interviews.

4.2.2 Data Collection

One-on-one telephone interviews explored physiotherapists' perceptions and experiences treating people with T2D using a semi-structured interview guide (Table 3), which were conducted by the first author from November 2020 to August 2021. We developed the interview guide in conjunction with guidance from a member outside of the research team, who has extensive experience in qualitative research, using the ICCC and HCAB frameworks (Carrillo et al., 2011; Nuño et al., 2012). Participants were asked

to share their experiences and perspectives on patient care for people with chronic conditions, particularly T2D, sharing knowledge on community resources as well as barriers for people with T2D accessing physiotherapy services in terms of healthcare benefits and/or out-of-pocket expenses, the referral process, and patient and healthcare provider knowledge.

We played an active role in generating the findings through meaningful dialogue among the authors during iterative analysis of the interviews, as well as influencing participant responses with conduct of conversational style interviews (Bradshaw et al., 2017).

Table 3. Interview guide.

1. *What physiotherapy settings have you worked in? What setting are you currently working in?*
2. *Tell me about your experience treating patients with chronic health conditions?*
3. *What chronic health conditions to you treat/manage as a condition for referral?*
4. *Tell me about your experiences treating patients with T2D?*
5. *Tell me about a time where you treated a patient who was diagnosed with T2D as a co-morbidity. How did you address their T2D?*
6. *What are your perceptions on expanding caseloads to include T2D as a primary condition for referral?*
7. *What would be an example of an assessment/treatment session for someone coming to you with T2D as their primary condition for referral?*
8. *What are challenges/barriers for treating a patient with T2D?*
9. *How do you address patients who have risk factors for developing T2D?*
10. *How are patients with T2D currently being treating in your community?*
11. *What resources/referrals do you provide your patients with T2D?*
12. *What education/training have you received for T2D/chronic health conditions?*
13. *What is your knowledgebase/experience with behaviour change strategies/motivational interviewing?*
14. *How do you implement behaviour change strategies/motivational interviewing when treating patients with T2D?*
15. *What are your perceptions on the stakeholders (e.g., physicians, nurses, nurse practitioners, diabetes educations, associations) awareness on the role physiotherapy as an intervention for T2D?*

4.2.3 Data Analysis

Interviews were audio recorded and transcribed by the first author and thematic analysis was used to analyze transcripts (Braun & Clarke, 2006). Transcripts were read and re-read to become familiar with the data and to generate initial codes. The first author developed the initial codes, developing a coding chart containing direct quotes from interview transcripts. The first author wrote memos regarding their impressions of the interviews, acknowledging their own assumptions and lived experiences as a physiotherapy student, which helped the author remain conscious of how their pre-understandings influenced interpretations of the data (Finlay, 2002). Reflections contained within the memos were shared during analysis of the findings by the authors. Clinical experiences of patients with T2D and academic curriculum were offered as points for comparison and reflection during analysis of the study findings. The second author [DC] reviewed the initial codes and provided feedback. Constructs from the ICCC and HCAB frameworks were referenced during data analysis to identify initial codes. For example, the subtheme *attitudes and beliefs towards T2D* is informed by the lack of urgency in management for patients with T2D, one of the foundational constructs in the ICCC model (Figure 2). Significant and relevant codes were identified across the data set and grouped together by the two authors independently first to generate potential themes. The two authors had regularly scheduled meetings throughout the data collection and analysis process to compare, define, and name the emerging themes (Braun & Clarke, 2006). Data collection and analysis were conducted concurrently as new questions emerged that were asked in subsequent interviews to allow for a deeper understanding of participants' experiences (Green et al., 2007). A consensus was achieved on the

developed themes by all authors. Data collection stopped when no new codes were being generated during analysis of the interviews.

4.2.4 Quality

In brief, following Tracy (2010), our study highlights a worthy topic, which is relevant and timely. With the increasing prevalence of T2D in the world population, we demonstrate the impact physiotherapists can have on T2D self-management through exercise. Rigour was achieved by collecting 21 interviews sufficient in length and richness (Tracy, 2010). Sincerity was established using memos and explicitly stating the authors pre-understandings and background in the field. Credibility was achieved through triangulation, where two authors were involved in data analysis to generate themes (Tracy, 2010). In terms of resonance, the findings are transferable to other chronic conditions, as there has been a 'Call to Action' for the uptake of chronic health conditions by physiotherapists (Dean et al., 2016). We believe the present study has the potential to improve practice and empower physiotherapists and their respective colleges and associations to promote the physiotherapy profession as a valuable healthcare provider for the management of T2D, thus achieving significant contribution to improve patient outcomes (Tracy, 2010).

4.3 Results

In addition to the CPA and Orthopedic Division, Colleges/Associations from 11 provinces and territories responded to our request and distributed the email containing our study information to their members. Twenty-one participants (Table 4) from eight provinces and territories completed an interview, which lasted from 40 to 75 minutes in duration; all interviews were conducted by the same author [SJ]. The analysis of the

interviews revealed three themes related to current T2D management and the potential impact physiotherapists can have (Figure 2). Theme one, *current approach to T2D management*, described the current healthcare team for T2D and the lack of awareness of what physiotherapists can offer by other healthcare professionals. Theme two, *challenges for physiotherapy integration*, revealed the barriers for expanding the physiotherapy caseload to include T2D. Lastly, theme three, *merits of physiotherapy and needed evolution*, described how physiotherapists' scope of practice contains the skillset and knowledge to help manage T2D and discussed a potential new direction for physiotherapy.

Table 4. Participant characteristics.

Participant	Gender	Degree	Years of practice	Current Setting
P1	Female	Master's	14	Outpatient musculoskeletal rehab
P2	Female	Master's	3	Outpatient unit in hospital
P3	Female	Bachelor's	12	Private practice mobile care
P4	Male	Master's	14	Outpatient private practice
P5	Female	Bachelor's	25	Community – chronic disease management
P6	Female	Master's	12	Public setting – orthopedics
P7	Female	Master's	22	Home and community care
P8	Female	Bachelor's	37	Home and community care
P9	Female	Master's	21	Outpatient private practice
P10	Male	Bachelor's	30	Private community care
P11	Female	Master's	4.5	Outpatient private practice

P12	Female	Master's	15	Outpatient private practice
P13	Female	Bachelor's	23	Outpatient private practice
P14	Female	Master's	3	Outpatient pediatrics
P15	Female	DPT	16	Outpatient private practice
P16	Male	Master's	1	Outpatient private practice
P17	Female	Bachelor's	33	Private home and community care
P18	Female	Master's	3	Outpatient private practice
P19	Female	Master's	10	Outpatient private practice
P20	Female	Bachelor's	20	Outpatient private practice
P21	Female	Bachelor's	39	Home and community care

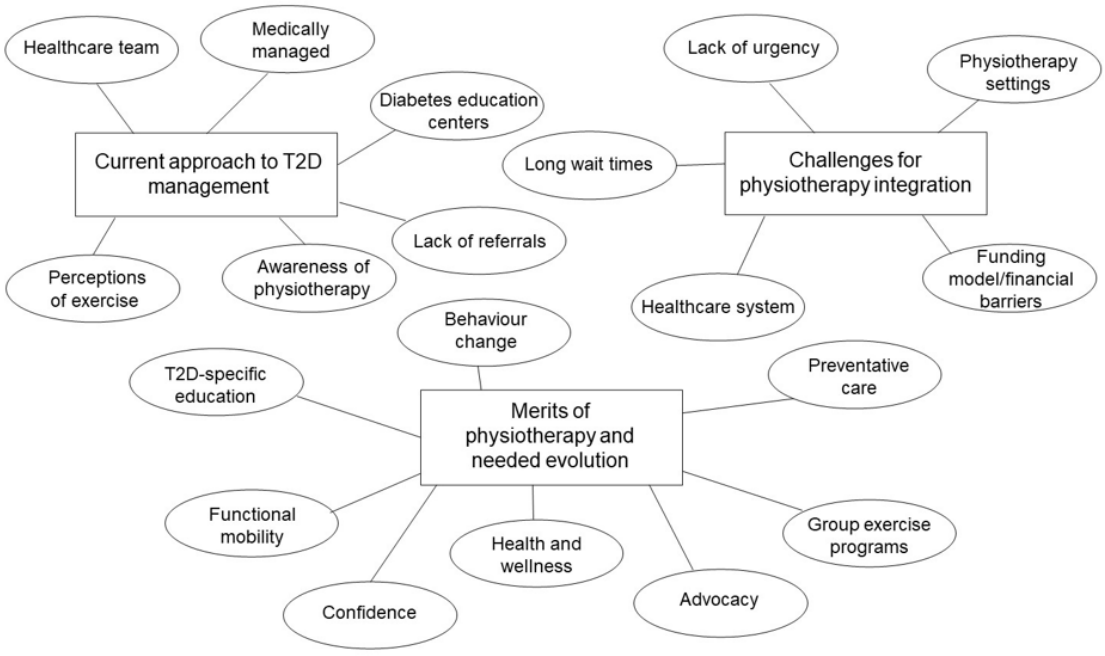

Figure 2. Thematic map showing three main themes (rectangles) with associated codes (ovals).

Theme one: Current approach to T2D management

Physiotherapists described T2D management under the biomedical model of care, predominantly managed through medication: “you can see it in the way they’re managed already, just drugs and, you know, passive advice” (P18). Referrals to diabetes education centres were common, which were run by physicians, nurses, diabetes educators, and a dietitian, with the aim of monitoring blood glucose levels and diabetes complications. Despite physiotherapists treating patients with T2D as a co-morbidity, the thought of providing direct care was not a common thought. “I think of it as more of a disease that we manage in the hospital or in the doctor’s office” (P15).

Healthcare team

Physiotherapists were well-informed about how people living with T2D were currently being treated in their communities. “They have a family physician, and they get to see the diabetic nurse educator once every three months” (P5). Ten participants mentioned a diabetes education center in their community. “So we have a diabetes education center that has an RN and a dietitian” (P17). Despite support for people living with T2D in these communities, exercise was not at the forefront for T2D self-management. People with T2D were provided with education regarding lifestyle modifications, however, physiotherapists expressed frustration with how this information was being relayed. “Exercise and nutrition are the two primary treatments for this, but we don’t hear about the exercise piece more than just like a passing ‘oh, you should exercise too’” (P3). In particular, the diabetes education centers are designed to provide educational opportunities for people with T2D to help them self-manage and provide basic counseling regarding exercise. “They’re getting bombarded with information. Like, it’s an absolute avalanche of information and they’re going to be scattered” (P7).

However, physiotherapists, not currently part of the healthcare team for T2D, can provide more in-depth counseling on appropriate and safe exercise tailored to each individual. “You can’t just tell people that they should start walking when they have mobility issues or other challenges” (P8).

Awareness of the physiotherapy profession

The current and potential role of physiotherapy to aide in the direct management of T2D has been largely unrecognized by healthcare providers, patients with T2D, and physiotherapists. “We think of the physiotherapist for the sprained ankle” (P12). Traditionally, physiotherapists have been recognized for treating musculoskeletal injuries and conditions although, have been trained to treat and manage chronic conditions, including T2D. “I think there’s been sort of a history that we haven’t been involved in the management of T2D, but I don’t really see why” (P15).

Physiotherapists do have experience treating diabetes complications, such as amputations and peripheral neuropathy. Physiotherapists could have a greater impact treating patients earlier in their diagnosis with exercise and education to help mitigate disease progression. However, primary prevention or early management of T2D is not the current practice. “I think [physicians] see us as dealing with the problems that pop up from diabetes as opposed to kind of the initial management” (P1). One reason for this disconnect between the perception of the physiotherapy profession and physiotherapists’ knowledge is a lack of awareness of physiotherapists’ scope of practice by physicians, as perceived by participants. “I suggested physio would be helpful and this doctor said, ‘oh, well physios, they don’t really, not too many physios know much about diabetes” (P21). To address the disconnect, education about the profession was suggested. “I guess for

physiotherapists to be able to work in a model where we're seeing people with [T2D] as a primary referral, it would have to be the family docs… we would have to educate them to do that" (P20).

Theme two: Challenges for physiotherapy integration

Barriers for physiotherapy integration into the healthcare team for people with T2D were based on social determinants of health. Patients' attitudes and beliefs towards T2D, older age, finances, and accessibility to services were described by study participants. Nevertheless, all 21 participants expressed the need and interest for inclusion of physiotherapy as part of the healthcare team for T2D management. "It saves so much money for the healthcare system and that's what I wish more people were aware of. We can save surgeries and diagnostic tests just by getting people moving better and educating them" (P9).

Attitudes and beliefs towards T2D

Physiotherapists viewed their patients with T2D as having a lack of urgency for managing the condition. This was, in part, due to the increasing number of co-morbid conditions in older adults that physiotherapists treat. "It's not taken very seriously. It's more just like 'throw it in the bag, I've got way bigger things to worry about'" (P3). This attitude towards T2D, perceived by physiotherapists, continued after the development of complications: "Generally speaking, we end up getting people at a stage of their diabetes that they have major complications and half of them don't care" (P7). Physiotherapists themselves don't always acknowledge the seriousness of the condition, given a high prevalence of patients with T2D as a co-morbidity coming to outpatient physiotherapy. "It's such a common pathology that it's kind of almost just written off" (P19).

Socioeconomic status

T2D is prevalent in both publicly and privately funded physiotherapy settings. However, from physiotherapists' experiences, T2D is more common in people with lower socioeconomic status and therefore, often seen in publicly funded settings. "Money might be a bit of an issue so, anybody, I don't know this, but probably proportionately those with less access to funding probably have a higher incidence of diabetes" (P10). Publicly funded community settings, including home care, are for individuals with significant mobility impairments living in the community and who often live with multiple co-morbid conditions. "[T2D] is more prevalent in the community setting… more of my community patients, lower socioeconomic status, older individuals, just more at risk of having it" (P2).

Accessibility

Access to publicly funded physiotherapy is limited, making it difficult for individuals with T2D without extended health benefits to seek services. In publicly funded community settings, the number of physiotherapy visits are insufficient for people requiring long-term follow up and reserved for those with significant impairments. "We definitely have very strict criteria that it should only be people that are not really mobile… It's obviously the pretty severe people" (P21). Eleven participants were currently practicing in rural areas where physiotherapists are lacking, making accessibility difficult. "Our wait times are so horrendous in the rural areas… a lot of conditions right now for the most part are on the wait list for close to two years" (P6). Common practice for physiotherapists is to utilize physiotherapy assistants and registered kinesiologists to continue with treatment sessions to improve accessibility and

reduce costs. “I’ve taken on a more consultative role using PTAs more. That helps with your accessibility and your cost” (P17).

Funding

Better access to physiotherapy for people with T2D requires funding. In communities, when patients were first diagnosed with T2D, they were referred to a diabetes education center and/or a dietitian. If patients were referred to physiotherapy for exercise counseling to manage T2D, that would burden the already “chronically short-staffed physiotherapists” (P21). “We would need funding… I think if it was just an automatic referral for every type 2 diabetic that was diagnosed, we would be overwhelmed” (P7). Physiotherapy for T2D as the primary condition of referral, if referred to publicly funded physiotherapy, would require increased funding from the government. “Now it’s a little bit more expensive for the public system to be paying for these things” (P4).

Theme three: Merits of physiotherapy and needed evolution

Physiotherapists have the foundational knowledge and skillset to provide exercise education and prescription for people living with T2D. There is a need for the physiotherapy profession to evolve and take a primary prevention approach to T2D to improve self-management and help prevent the development of complications. “I mean, preventative is always better. Less health conditions and less complications and then they can hopefully manage themselves for longer periods of time without needing the increased intervention that people need down the road” (P17). There are also advantages for physiotherapists to see patients newly diagnosed with T2D, which would require further promotion of the profession to primary healthcare providers and patients

themselves. “The closer that you can get involved with somebody to their actual diagnosis, the more apt that they are to get involved with making these changes… they seem to be more pliable and willing to participate” (P6).

Scope of practice

Physiotherapy assessments for people with T2D would involve a subjective history on how T2D is being managed as well as goals for treatment. “Knowing the history of sort of how it’s been managed thus far and any complications that they’ve had with it” (P20). Objective assessments would focus on functional mobility and assessing overall fitness, as goals for physiotherapy could be to improve aerobic capacity, improve balance for those with peripheral neuropathy, and participate in safe exercise. “Even just look at sit-to-stands, you could do something like timed up-and-go’s and then walking and timing how fast they can walk, the 10 meters, doing more kind of endurance-based tests” (P11).

The predominant treatments for patients with T2D consist of education and exercise. Education on T2D: “basic foot care and foot hygiene” (P11) and in relation to exercise: “I might talk about managing sugars surrounding exercise so just checking your sugar before and after exercise” (P14) are within the scope of physiotherapy. Physiotherapists emphasize a tailored treatment plan based on a patient’s goals and consider overall health and wellness.

Wholistic approach to treatment

Addressing lifestyle factors are incorporated into physiotherapy sessions, especially when treating people with chronic health conditions. “You’re not assessing one specific injury or joint, your kind of taking a whole body, wholistic approach and

really, it's about lifestyle management" (P1). Although physiotherapists' focus is on exercise, they were aware about healthful nutrition and knew when to make a referral but were not comfortable providing nutrition advice to their patients. "I've referred individuals to nutrition education in the community setting. So, they're not just specialized in diabetes but they kind of talk about controlling their weight and BMI and a healthy diet" (P2). Weight management helps to control blood glucose levels and prevents diabetes complications but can be a difficult conversation. Physiotherapists addressed weight management if it was a patient's goal or framed around exercise.

> I don't feel like it's an easy thing for any of us to lose weight and most people have tried or trying… I just try to be supportive with their goal of trying to lose weight and encourage the exercise portion of it (P13).

Poor sleep has been associated with poor nutrition and weight gain (Chaput, 2014). Physiotherapists can provide exercise counseling and prescription to help improve sleep. "Are you looking for ways to sleep better and relax before you sleep so it's a better quality? So, I would sort of do a patient-centered focus" (P9).

To promote exercise and physical activity adherence, physiotherapists designed exercise programs that patients find enjoyable. "I think if you don't find something that somebody enjoys then they're not going to do anything a month later" (P19). Participants educated patients on how to incorporate exercise and physical activity into daily life and helped come up with strategies. "We would talk about mall walking and then they could grab a coffee afterward. Like we could make it not this total lifestyle change, but something that could be social and physical" (P20).

Advanced training

Despite receiving education on T2D in entry-to-practice physiotherapy programs, physiotherapists felt that post-graduate education was needed to be able to effectively treat T2D. “Right now, in terms of how [T2D] is taught in schools… I don’t think physios coming out of school right now have the skillset” (P16). In terms of T2D-specific knowledge, physiotherapists felt least confident with providing education around blood glucose levels. “I don’t know enough about A1C levels to tell them ‘okay, here’s exactly where I want you hovering’” (P10).

Motivational interviewing and behaviour change strategies are common tools to promote healthy lifestyle changes, which is available through post-graduate education. “I think it would be appropriate if the therapist was ready to take on further training in those areas of like cognitive behavioural therapy, motivational interviewing, health coaching” (P12). Physiotherapists displayed varying degrees of confidence for treating T2D. Even with motivational interviewing training and a knowledgebase in T2D, physiotherapists thought additional training would be necessary.

> I think I would be partially prepared. Like, I have some background in terms of goal setting, motivational interviewing and background on some of the physiology of T2D, but I think that post-graduate education would be important… online courses or something like that (P14).

Promoting physiotherapy for T2D management

The physiotherapy profession does not promote the full breadth of their scope of practice when it comes to treating chronic health conditions. This may be due to funding and capacity limitations and adhering to the traditional role of physiotherapy. “What we advertise, like nowhere on our website, it doesn’t have diabetes on there. I don’t think

I've ever seen that on an MSK physio website" (P18). "We don't do a great job highlighting our strengths and where we could play a role" (P15). An evolving role for physiotherapy is needed as more people are living with chronic health conditions. One-on-one sessions and supervised group exercise were solutions to providing care for people with T2D. Similar to other patient populations, such as those with osteoarthritis, physiotherapy-designed group exercise programs can promote exercise and improve mobility in people with T2D.

> Maybe we should start thinking about having some kind of exercise program once a week in clinics that can manage that for people that need to be monitored with their exercises… I mean we've got the GLA:D™ program going on for knees now, maybe there needs to be something in that framework for people with diabetes (P13).

4.4 Discussion

The main finding of our study was support from participants for the uptake of T2D as a primary condition for referral to physiotherapy. Study participants stated physiotherapists could add to T2D management through exercise education, prescription, monitoring and progression. Participants emphasized knowledge in, and implementation of behaviour change strategies to promote better health outcomes for their patients with T2D. However, barriers for inclusion of physiotherapy included attitudes and beliefs towards T2D, accessibility, and funding. Participants acknowledged that promotion of the profession was needed to incorporate T2D.

Participants portrayed the current practice for T2D management in Canada as within the realm of physicians and nurses as the primary care providers who often

diagnose T2D. Participants identified advocacy by physiotherapists to physicians as necessary to promote awareness for the incorporation of people with T2D into physiotherapy caseloads. One cross-sectional study of 280 physicians reported 75% of physicians had some knowledge of the physiotherapy profession with only 11% often referring patients to physiotherapy services (Al-Eisa, et al., 2016). The study highlighted the need for further education and awareness of physiotherapy for physicians (Al-Eisa et al., 2016), as participants noted a physician's referral may be required for physiotherapy fees to be covered by extended health benefits. One study examined the utilization of motivational interviewing by family physicians to educate patients with T2D about self-management of lifestyle factors (Rubak et al., 2006). Physicians who used motivational interviewing were reported to be more effective than standard care when treating patients with T2D (Rubak et al., 2006). However, many physicians do not have time to effectively implement motivational interviewing in day-to-day practice (McMillan et al., 2016). More often, physiotherapists schedule longer appointments for patients which provides the needed time to effectively implement motivational interviewing (Dean, 2009; Dean, 2009). Assessing motivation of the patient and implementation of behaviour change are competencies in Canadian physiotherapy programs (CCPUP, 2019). With this, physiotherapists have incorporated motivational interviewing and behaviour change in other patient populations, including chronic pain, chronic low back pain, and older adults (Arkkukangas et al., 2017; Harman et al., 2014; Nijs et al., 2020), positioning physiotherapists well to transfer this skillset to patients with T2D. Other studies have reported on the role of diabetes nurse educators in the management of T2D (Matthews et al., 2005; Sen, 2005), which was often described by participants in our study. A case

study examined an education program for diabetes nurse educators emphasizing exercise counseling (Matthews et al., 2017). Findings highlighted challenges nurses face with employing exercise counseling due to a lack of training in motivational interviewing (Matthews et al., 2017). This perceived gap in the lack of exercise counseling for people with T2D was noted by participants in our study. Alternatively, physiotherapists use exercise as a primary modality in their practice (Gulve, 2008), in comparison to 17% of 159 physicians, who had received exercise counseling training, based on findings from a survey study of exercise counseling for patients with T2D (Joyce & O'Tuathaigh, 2014).

A scoping review identified chronic obstructive pulmonary disease (COPD), chronic pain and arthritis as primary chronic conditions managed by physiotherapists (Richardson et al., 2014). For example, a qualitative study explored the role of physiotherapy in hospital-based interprofessional chronic pain clinics in Ontario (Thacker et al., 2020). Physiotherapists focused on improving pain management strategies by promoting physical activity and exercise (Thacker et al., 2020). However, to our knowledge, a direct role of physiotherapy for T2D has been largely unrecognised in the Canadian healthcare system. Participants in our study supported these findings. Their understanding of the roles of physiotherapists who provide treatment for people with T2D are related to diabetes complications such as lower limb amputations and peripheral neuropathy, which is supported by previous studies (Agrawal et al., 2010; Kim et al., 2012; Ülger et al., 2018). However, physiotherapy program curriculum, aligned with The National Physiotherapy Entry-to-Practice Curriculum Guidelines (2019), educates students to be knowledgeable about the aetiology, signs and symptoms, differential diagnoses, medical and surgical management, and physiotherapy

interventions for T2D as well as behavioural change strategies (CCPUP, 2019). Participants noted this gap between education and practice and acknowledged that the status quo for physiotherapists is to treat musculoskeletal injuries where T2D is viewed as a co-morbidity. Our findings support a previous survey of course instructors providing T2D content in graduate physiotherapy programs across Canada (Janssen et al., 2022). The survey reported that more than half of respondents did not perceive adequate attention given to T2D in the physiotherapy curriculum despite agreement that T2D is integral to education of future physiotherapists (Janssen et al., 2022).

Although, study participants expressed confidence managing T2D through exercise education and prescription in our study, additional training in T2D was noted as essential to be able to adequately care for this patient population, including T2D-specific training and motivational interviewing. Lifestyle modifications are the first line of defense for T2D management, encompassing exercise and physical activity, nutrition, smoking cessation, and sleep and stress management. Although there is support for physiotherapists to provide lifestyle counseling beyond exercise (Frerichs et al., 2012), effective nutritional counseling is not addressed in the Canadian entry-to-practice physiotherapy programs (CCPUP, 2019). Notably, study participants were not comfortable providing advice on nutrition and did not feel nutritional counseling was within their scope of practice. Similarly, a survey study of 401 physiotherapists across Canada reported confidence with providing exercise education but lacked confidence with providing education on diabetes complications, weight-management, blood glucose management, and nutrition (Doehring et al., 2016). As well, only 32.4% of participants were addressing T2D in their caseloads (Doehring et al., 2016). Barriers for

physiotherapists addressing T2D was cited as lack of training (Doehring et al., 2016) with our study reporting lack of physician referrals and awareness, and funding/accessibility to physiotherapy services. A survey study of 220 physiotherapists reported lack of time, access to health promotion resources, interest from the physiotherapist or patient, and expertise as barriers to implementing lifestyle counseling, particularly with nutrition (O'Donoghue et al., 2014). Research and policy changes regarding legislation, practice standards, clinical competencies, and curriculum are needed to better position physiotherapists to encourage health promotion and wellness (O'Donoghue et al., 2014).

Accessibility to physiotherapy services was a barrier to integrating T2D into physiotherapy caseloads. Long wait times for publicly funded physiotherapy, living in rural locations, and limited physiotherapists contributed to reduced accessibility. Focus groups and individual interviews exploring accessibility to physiotherapy for people with a disability and their carers living in a rural location generated themes of 'traveling to access therapy' and 'waiting a long time to get therapy' (Dew et al., 2013). Recruitment and retention of physiotherapists in rural locations were key challenges (Dew et al., 2013). Participants connected a higher prevalence of T2D with having a lower socioeconomic status, which is supported by the literature (Connolly et al., 2000). Socioeconomic status considers ethnicity, disability, geographical location, nutrition, income level, education level, housing conditions, access to social support, and exposure to environmental risk (Perry et al., 2015). Difficulty accessing physiotherapy was associated with a lower socioeconomic status and lower health literacy (Perry et al., 2015). Health promotion initiatives to educate the public, as well as increased supports

and funds are necessary to improve access to physiotherapy for people of lower socioeconomic status, which have a higher proportion of co-morbid conditions.

A systematic review reported weak to moderate evidence supporting direct access to physiotherapy led to improved healthcare efficiency and reduced healthcare costs compared to a physician's referral for people with musculoskeletal disorders (Demont et al., 2021). A survey study reported that of 8822 people waiting for publicly funded physiotherapy in Ontario (57% response rate of publicly funded cites across Ontario), 73% had chronic conditions (Passalent et al., 2009). The median wait time for community physiotherapy for patients in hospital was 29.3 days with a wait time as long as 140 days (Passalent et al., 2009). Client acuity, teaching self-management strategies, attendance policies and wait list audits were noted as strategies for managing long wait times in Ontario (Passalent et al., 2010). Further research is needed to assess physicians' awareness on the benefits of physiotherapy for people with T2D, as well as re-evaluation of the current funding model of physiotherapy in Canada to include better accessibility for people with chronic health conditions, including T2D.

Interventions, including one-on-one sessions or supervised group exercise, are represented by Theme three. The literature supports physiotherapy-led exercise for people living with T2D. Although one RCT did not report statistically significant findings for one-repetition maximum for chest press, leg press, or exercise capacity, as measured by a graded exercise test for endurance (in minutes) after a two-month physiotherapy-led exercise program (Taylor et al., 2009), functional outcomes (e.g., walking speed), may be more relevant for people with T2D, as emphasized in our findings. A recent systematic review of RCTs of exercise interventions for people with

T2D reported significant improvements in 6MWT ($p<0.05$) and CST ($p<0.05$) scores, as well as improved blood glucose levels ($p<0.05$) (Janssen & Connelly, 2021). These statistically significant improvements indicated that supervised exercise may provide improved function for people with T2D, particularly those who have peripheral neuropathy or retinopathy (Gupta et al., 2017; Timar at el., 2016). Additionally, an eight-week supervised education and exercise program was designed specifically for people with T2D and led by a physiotherapy student (Janssen et al., 2022, in review). Janssen et al. (2022, in review) conducted a mixed methods case series design study and reported improvements in all physical function outcome measures including the 6MWT, timed up-and-go (TUG), 30-second CST, and arm curls (Janssen et al., 2022, in review). Findings from interviews one-year after the exercise intervention emphasized the importance of exercise in the management of T2D and the value of motivation for exercise adherence (Janssen et al., 2022, in review).

4.4.1 Limitations

We were unable to recruit participants from all provinces and territories in Canada and therefore, our results may not have captured current physiotherapy practice across Canada in community and clinical settings. Although the themes presented remained close to the data, our findings are one interpretation of the interview transcripts.

4.4.2 Conclusion

Our study explored physiotherapists' perspectives about including T2D as a primary condition for referral. Participants acknowledged the role physiotherapists could play, including one-on-one education and coaching, and supervised group exercise.

According to participants, better communication and awareness of skills and knowledge about physiotherapy may be needed between physicians and physiotherapists to increase referrals to physiotherapy services. Further research is needed on the feasibility for inclusion of T2D management in physiotherapy caseloads, pertaining to funding and accessibility as well as physiotherapists' self-efficacy for providing lifestyle counseling beyond exercise.

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Chapter 5

Assessing physical function after completing a supervised education and exercise program in adults with type 2 diabetes and exploring exercise motivation at one-year follow up: A case series study[3]

5.1 Introduction

Regular exercise helps to improve glycemic control, blood lipid profiles, blood pressure, and helps prevent diabetes complications (Balducci et al., 2014; Thomas et al., 2006; Yang et al., 2014). The Clinical Practice Guidelines for physical activity and diabetes recommends 150 minutes per week of moderate intensity (defined as 64-76% maximum heart rate) aerobic exercise and two to three sessions of progressive resistance training per week (Sigal et al., 2018). Supervised exercise programs are recommended over unsupervised exercise, as evidence suggests further improvements in glycemic control, physical fitness, and body composition (Balducci et al., 2010; Gordan et al., 2009; Sigal et al., 2018). However, diabetes-related disability due to the development of peripheral neuropathy, visual loss, cardiovascular disease, and obesity, pose challenges to engaging in regular exercise (Gretebeck et al., 2019; Yang et al., 2014). In a survey study of 6097 adults (≥ 60 years) with T2D, 73.6% of respondents reported disability in general physical activities and 52.2% of respondents reported disability in lower extremity mobility (Kalyani et al., 2010).

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[3] A version of this study has been accepted for publication: Janssen, S.M., Connelly, D.M., Shields, C., & Landry, M. (2022). Assessing physical function after completing a supervised education and exercise program in adults with type 2 diabetes and exploring exercise motivation at one-year follow up: A case series study. *Physiotherapy Theory and Practice,* 1-14. Doi: 10.1080/09593985.2022.2097968.

Physical function is the ability to perform day-to-day activities (i.e., walking, stairs, lifting) and comprises strength, endurance, balance, and flexibility and measures include the 6MWT, 30-second CST, TUG test, arm curl test, sit-and-reach test, and back scratch test (Rikli & Jones, 1999). Alfonso-Rosa et al. (2013) reported that the 6MWT, TUG, and 30-second CST are reliable outcome measures in adults with T2D with intraclass correlation coefficients (ICC) of 0.99, 0.98, and 0.92, respectively. The 6MWT and the 30-second CST were also found to be validated measures in this population (Leenders et al., 2013; Nolen-Doerr et al., 2018). Although not validated in adults with T2D, the TUG test assesses balance, which is impaired in people with T2D secondary to peripheral neuropathy and retinopathy, affecting the somatosensory and visual systems (Dixon et al., 2017). Apart from physical limitations, extrinsic and intrinsic motivation impacts a person's ability to participate in regular exercise and physical activity.

The self-determination theory describes human motivation and considers intrinsic and extrinsic influences such as self-regulation, personal goals, and aspirations as well as the effects of culture and socioenvironmental factors and is described as a continuum of amotivation, extrinsic motivation, and intrinsic motivation (Deci & Ryan, 2008; Ryan & Deci, 2000). A systematic review reported that identified regulation, based on what the person deems important, predicted initial adoption of exercise participation compared to intrinsic motivation, which is engaging in a behaviour for satisfaction and enjoyment, but intrinsic motivation was more predictive of long-term exercise adherence (Deci & Ryan, 2008; Ryan & Deci, 2000; Teixeira et al., 2012). Physiotherapists are trained to identify motivation, self-efficacy, and barriers to exercise. A systematic review of qualitative studies exploring patient-centered care in physiotherapy practice reported that

physiotherapists taking a patient-centered care approach adopted individualized treatment plans, had strong communication skills, provided education throughout treatment, worked with patient-defined goals, and empowered patients (Wijma et al., 2017).

Physical impairments, motivation, and other contextual factors influence a person's perception of engaging in regular exercise and physical activity. A systematic review analyzed health-related self-care activities in adults with T2D, which was overall poor. Regular exercise was the least reported self-care activity with medication adherence the most frequently reported (Barbosa da Rocha et al., 2020).

Currently, T2D care in Canada is managed through the chronic care model (CCM) that consists of care in the healthcare and community systems with an interdisciplinary health team (Stellefson et al., 2013). Although self-management support groups provide benefits (Foster et al., 2007), self-management programs or diabetes education centers do not always provide 1) tailored exercise programming, or 2) long-term support to encourage behaviour change. Despite evidence supporting exercise in the management of T2D, physiotherapists, as exercise specialists, are not currently part of the healthcare team for adults with T2D in Canada. Physiotherapists are well-positioned and knowledgeable to manage T2D through exercise education and prescription either one-on-one or in a group-based setting. Physiotherapy-led exercise programming can lead to clinically significant improvements in physical function and anthropometric measures without significant adverse events (Higgs et al., 2016). Therefore, we sought to explore how the "Get Fit for Active Living with Diabetes" (GFAL-D), a supervised eight-week exercise and education program led by a physiotherapy student and

developed by the Canadian Centre for Activity and Aging (CCAA) (Scholey et al., ©2010 [unpublished]), influences changes with exercise in adults with T2D and explore motivation towards exercise adherence.

The purpose of this study was to a) measure change in fasting blood glucose, blood pressure, anthropometrics (i.e., BMI, waist circumference), and physical function (i.e., endurance, agility and balance, upper- and lower-body strength, flexibility) after completing the GFAL-D; and b) understand the experiences of exercise continuation in people living with T2D one-year after completing the GFAL-D. A similar program was previously piloted for community-dwelling older adults, which reported an adherence rate of 66% at the 12-month follow-up (Stathokostas et al., 2017). Stathokostas et al. (2017) reported on facilitators and barriers to exercise adherence and identified maintaining health as a reason for continuing, and illness and lack of motivation as reasons for discontinuing regular exercise.

5.2 Methods

A mixed methods case series design was conducted using purposive sampling (Dekkers et al., 2012; Fetters et al., 2013; Kooistra et al., 2009). This study design was employed to allow for exploration of patient experiences following an intervention intended to assist them to self-manage their T2D diagnosis, and to provide authentic experiences of a condition that can be managed by physiotherapists but is not currently a diagnosis of referral in Canada. Participants were recruited using flyers posted at medical offices and community centres offering programs and social events for adults in a midsized city in Ontario, Canada. Included participants were ≥ 18 years, had a clinical diagnosis of T2D (glycated hemoglobin (A1C) ≥ 6.5%), owned a smartphone or tablet,

had cognitive and physical ability to participate in an education and exercise program, and were fluent in English. Participants with diabetes complications (e.g., neuropathy, amputation) were included if they a) had medical clearance from their primary care provider and b) were able to physically participate in an exercise program. Study volunteers taking insulin or engaged in regular physical activity or exercise within the last month defined as scoring 'high' on the IPAQ were excluded. This study was approved by Western University's Health Sciences Research Ethics Board (112495) and written informed consent was obtained from all participants.

5.2.1 Intervention

Exercise screening

Eligibility of participants to engage in safe moderate intensity exercise was established using the PAR-Q, which is a well-recognized and validated pre-screening tool (Thomas et al., 1992). If a participant answered yes to any one question, they were required to obtain medical clearance to exercise from their primary healthcare provider and completion of the Physical PARmed-X (Canadian Society for Exercise Physiology, 2002).

GFAL-D program

The GFAL-D, an eight-week education and exercise program, was provided free of charge to study participants at a local centre for older adults during 2018-2019. The GFAL-D program was led by a physiotherapy student, certified as both a GFAL-D and Senior Fitness Instructor, working with a licensed physiotherapist. In groups of two to five, participants gathered two times a week. Tuesdays consisted of a one-hour education session and one-hour exercise session and Thursdays consisted of a one-hour exercise

session in a gymnasium. The education sessions addressed each of the following topics sequentially: exercise adherence; cardiorespiratory exercise; muscle strength and endurance; stretching, flexibility and balance; healthy eating; disease prevention; exercising at home and exercise program options. The GFAL-D program does not include a prescribed method to log nutrition. The free, easy-to-use mobile health application MyFitnessPal™ (https://www.myfitnesspal.com/) was chosen to track exercise and food intake during the GFAL-D intervention and after completing the GFAL-D. Participants were led in a hands-on, guided introduction on how to download, navigate and use the MyFitnessPal™ App to track daily exercise participation and nutritional intake.

Supervised exercise sessions consisted of a five-minute dynamic warm up, 20 minutes of cardiorespiratory exercise, 20 minutes of strength training, 10 minutes of balance exercise and a five-minute stationary cool down. The five-minute warm up consisted of walking combined with range of motion movements of the major joints (e.g., shoulder, elbow, wrist, hip, knee, ankle). Cardiorespiratory exercise consisted of brisk walking around the gymnasium perimeter while performing upper extremity exercises holding 1–2-pound dumb bells or step aerobics using 8-inch plastic risers. Heart rate was monitored at 10 minutes and the end of the 20-minute aerobic component, using the radial or carotid artery, to ensure the target heart rate zone of 65-80% age-predicted maximum heart rate was achieved. Strength training consisted of two sets of eight to 12 repetitions with the aim of reaching 3-5 using Rating of Perceived Exertion (RPE) (Borg, 1982), using dumbbells, resistance bands, ankle weights and body weight, of eight exercises consisting of compound (i.e., multi-muscle, multi-joint) and single-

joint exercises targeting the major muscle groups (i.e., biceps, triceps, deltoids, pectorals, trapezius, erector spinae, abdominals, quadriceps, hamstrings, gluteals, adductors, abductors, gastrocnemius and tibialis anterior). Additionally, muscular endurance exercises for the erector spinae and abdominal muscles, such as forearm plank with feet together (Park & Park, 2019) and bird-dog (Calatayud et al., 2019) in two sets of 15-20 repetitions or 20-second holds were completed. Variations of stationary and dynamic balance exercises were performed as able, to progressively challenging participants by decreasing the base of support (e.g., standing feet together, tandem standing, standing on one foot (Berg et al., 1992). In a five-minute cool down, participants were led through a series of static stretches for the major muscle groups (e.g., wall chest stretch, rear deltoid stretch, seated single leg hamstring stretch, wall supported standing quadriceps stretch, standing side lunge stretch).

5.2.2 Outcome Measures

Questionnaires

Participants completed the BREQ-2 (Markland & Tobin, 2004) pre- and post-GFAL-D. The IPAQ (Craig et al., 2003) was used to identify participants as engaging in low, moderate, or high physical activity levels prior to participation in the GFAL-D program based on Metabolic Equivalent for Task (MET) minutes per week (MET-minutes/week). Participants completed a demographic questionnaire including sex, age, years since T2D diagnosis, current medications, T2D complications, other co-morbid health conditions, employment status, highest level of education, and marital status.

Anthropometric, blood glucose, and blood pressure measures

Participants' waist circumference using the halfway point between the ribcage and superior iliac crest (Ross et al., 2020), height, mass, and calculated BMI were obtained pre- and post-GFAL-D. Participants were requested to record and report their morning fasting blood glucose reading using their personal glucometer on the day of pre- and post-GFAL-D assessments. At pre- and post-GFAL-D assessments, participants rested in a chair for 5 minutes before blood pressure was measured three times, following standard test and rest interval methods, using a portable automatic blood pressure monitor (Omron modelHEM-711ACCAN, Burlington, ON) (Chobanian et al., 2003).

Physical function measures

Physical function was assessed pre- and post-GFAL-D using the following measures: the 6MWT, TUG, 30-second CST, arm curl test, sit-and-reach test, and back-scratch test. Standardized instructions were provided to participants for the 6MWT (American Thoracic Society, 2002); participants were instructed to walk at a self-selected pace for six-minutes, timed continuously using a stopwatch, around a rectangular perimeter of the gymnasium marked by pilons, taking breaks as needed. Walking slightly behind the participant, a rolling metre stick (Measure Master modelMM-12m, Rolatape, Spokane, WA) was used to record total distance walked in six minutes. For the TUG, participants were seated in a standard armchair in the 'start' position with their back against the chair, forearms resting on the arms of the chair. On the command 'go', participants were to stand up and walk at a comfortable and safe pace to a line on the floor 3 meters from the chair, turn and return to the chair to sit down. Time in seconds from the word 'go' to return sitting in the chair with their back touching

the chair back was recorded (Podsiadlo & Richardson, 1991). Participants performed one practice TUG and one timed trial.

One trial of each of the 30-second CST and arm curl test was completed. For the 30-second CST, participants were seated in a standard armchair with their back against the chair. Participants were instructed to stand up as quickly as possible to a full stand position and sit back down in the chair. The number of sit-to-stand movements completed in 30 seconds was recorded (Jones et al., 1999). To perform the arm curl test, participants were seated in an armless chair with back supported using the arm of their choosing. Participants were instructed to perform as many bicep curls as they could in 30 seconds with proper form; females used a 5 lb dumbbell and males an 8 lb dumbbell. The number of bicep curls was reported (Rikli & Jones, 1999).

For the sit-and-reach test, participants sat on the front edge of an armless chair extending the leg of their choosing and flexing the foot to rest the heel on the floor. Participants extended the same arm as the extended leg and reached as far forward as possible to the toes of their extended leg. The distance (cm) from the tip of the third digit to the anterior surface of the great toe was measured and recorded using a ruler (Rikli & Jones, 1999). For the back-scratch test, participants reached behind their head with one arm and behind their back with the other arm. Using a ruler, the distance between tips of the third digits was measured and recorded using a ruler (Rikli & Jones, 1999).

5.2.3 Interviews

Semi-structured individual interviews adopting a qualitative descriptive methodology were conducted by telephone one-, six-, and 12-months post-GFAL-D (Doyle et al., 2020). Interviews were recorded following expression of informed consent

by participants. Examples of interview questions included, *"Tell me about your current physical activity and exercise?"*, *"What do you like/dislike about exercise?"*, *"What are your goals in terms of exercise, your health or type 2 diabetes?"* and *"What advice would you give to someone who was newly diagnosed with type 2 diabetes?"*.

5.2.4 Data Analysis

BREQ-2 questionnaires were scored and graphed using Microsoft Excel 365 (St. Redmond, WA). Fasting blood glucose, blood pressure, anthropometrics, and physical function measures were summarized and presented in a separate scenario for each individual participant (Mathes & Pieper, 2017). Rather than calculating statistical significance, which is not the purpose of a case series design, outcome measures were compared to the minimal clinically important difference (MCID) for each outcome supported by the literature.

Audio recorded interviews were transcribed and thematic analysis was employed by the authors based on the method of Braun and Clarke (2006). The researchers embodied a pragmatist paradigm, considering multiple perspectives from participants and positions from both qualitative and quantitative data, making pragmatism a suitable paradigm for mixed methods research (Giddings & Grant, 2007; Johnson et al., 2007). Generated codes were sorted into groups to create broad themes supported by participant quotations (Braun & Clarke, 2006). Data analysis and collection were ongoing and iterative, which informed new questions in subsequent interviews to deepen our understanding of emerging themes. Interviews at one-, six- and 12-months provided an opportunity for member checking, where clarification and/or elaboration of participant

responses could be expanded. Codes and themes were discussed between the authors, and consensus was achieved on developed themes.

5.3 Results

Twelve participants completed the GFAL-D program and 11 completed all three interviews. The twelfth participant was lost to follow-up despite several attempts to contact them by telephone and email to complete the interviews. Participant characteristics are depicted in Table 5. The range of participant attendance (n=12) for the GFAL-D program was 87.5-100%.

Table 5. Participant demographic characteristics at enrolment to GFAL-D intervention (n = 12).

Participant	**Sex**	**Age (years)**	**Level of education**	**Employment**	**Marital status**	**IPAQ***	**Smoking**	**Duration since diagnosis (years)**	**Diabetes medication**	**T2D complications**	**Other Health Conditions**
1	F	68	University	Retired	Divorced	Mod.	No	<1	Metformin	Neuropathy	Hyper-lipidemia, arthritis
2	F	65	University	Retired	Divorced	Mod.	No	9	Metformin	None	HTN, hyper-lipidemia, rheumatoid arthritis, fibromyalgia, asthma, chronic back pain
3	F	77	University	Retired	Widowed	Mod.	No	17	Sulfonylurea	None	HTN, osteoporosis, chronic back pain

4	F	78	Highschool	Retired	Married	Mod.	No	30	Metformin	Neuropathy	HTN, hyper-lipidemia
5	F	30	College	Working	Married	Mod.	No	4	None	None	Chronic back pain
6	M	65	College	Retired	Married	Low	No	10	SGLT2 inhibitor, metformin	None	Hyper-lipidemia, hypo-thyroidism
7	M	81	Highschool	Retired	Married	Low	No	40	Glyburide, metformin	None	Osteoporosis, chronic back pain
8	M	54	University	Working	Married	Mod.	No	1	Metformin	None	Hyper-lipidemia
9	M	60	College	Retired	Married	Low	Yes	5	Sitagliptin, metformin	None	HTN
10	F	61	University	Retired	Married	Mod.	No	<1	Metformin	None	Asthma, arthritis, chronic back pain
11	F	60	Highschool	Working	Single	Mod.	No	5	Empagliflozin, sitagliptin, metformin, gliclazide	None	Hyper-lipidemia
12	M	71	Highschool	Working	Married	Mod.	No	<1	None	None	HTN, hyper-lipidemia

HTN, hypertension.

*IPAQ calculation for Walking Metabolic Equivalent for Task (MET)-minutes/week = 3.3*walking minutes*walking days, moderate MET-minutes/week = 4.0*moderate-intensity activity minutes*moderate days, and vigorous MET-minutes/week = 8.0*vigorous-intensity activity minutes*vigorous-intensity days.

5.3.1 BREQ-2

After the GFAL-D program, six participants scored higher on items associated with intrinsic motivation. Items associated with external motivation increased in four participants and decreased in two participants post-GFAL-D. One participant scored higher on items associated with amotivation post-GFAL-D. Identified motivation increased slightly in eight participants, remained unchanged in three participants and decreased in one participant.

5.3.2 Anthropometric, Blood Pressure and Blood Glucose Measures

BMI, waist circumference, blood pressure and self-report fasting blood glucose recordings pre- and post-GFAL-D program are shown in Table 6. Despite BMI remaining unchanged in all participants, seven participants had clinically significant (Minimal Clinically Important Difference (MCID) = -2 cm) (Brennan et al., 2020) reductions in waist circumference post-GFAL-D. Eight participants demonstrated clinically significant reductions in systolic blood pressure (MCID = -2 mmHg) (Wiles et al., 2017) and two participants had increased systolic blood pressure post-GFAL-D. However, five participants reported hypertension as a comorbidity, which was controlled by medication. Additionally, nine participants reported decreases in fasting blood glucose levels ranging from 0.1 to 1.2 mmol/L, although only two were clinically significant (Hordern et al., 2008; UK Prospective Diabetes Study Group, 1998).

Table 6. Anthropometric, blood glucose and blood pressure measures pre- and post-GFAL-D intervention by study participant (n = 12).

	Pre-GFAL-D					Post-GFAL-D				
Participant	**Mass (kg)**	**BMI (kg/m^2)**	**Waist circumference (cm)**	**Glucometer (mmol/L)**	**Blood pressure (systolic/diastolic) (mm Hg)***	**Mass (kg)**	**BMI (kg/m^2)**	**Waist circumference (cm)**	**Glucometer (mmol/L)**	**Blood pressure (systolic/diastolic) (mm Hg)***
1	90.7	36.6	118	7.3	122/77	89.8	36.2	118	6.6	139/69
2	98.0	38.3	121	4.5	140/82	98.0	38.3	117[b]	4.7	140/75
3	69.9	28.2	103	7.6	147/70	69.9	28.2	96[b]	6.4[d]	118/57[c]
4	105.2	37.4	120	6.4	144/58	104.3	37.1	119	5.7	142/66[c]
5	58.1	23.4	77	5.3	118/87	58.1	23.4	74[b]	4.7	113/72[c]
6	90.3	33.1	109	6.6	132/75	90.7	33.3	110	6.9	124/70[c]
7	85.7	32.4	114	6.7	135/71	84.8	32.1	114	6.4	132/73[c]
8	69.4	22.9	88	6.2	121/79	70.5	23.3	86[b]	5.1[d]	117/80[c]
9	88.0	27.5	112	6.5	139/82	85.0[a]	26.5	107[b]	6.4	121/80[c]
10	86.2	35.4	98	6.0	134/76	84.0[a]	34.5	96[b]	5.7	137/80
11	83.9	32.0	98	5.6	118/67	82.5	31.4	100	6.8	97/62[c]
12	99.8	28.5	105	9.1	140/85	98.5	28.2	103[b]	8.5	140/80

*Blood pressure is the average of 3 measures

[a]Body mass reduction MCID = -2 kg (Brennan et al., 2020)

[b]Waist circumference MCID = -2 cm (Brennan et al., 2020)

[c]SBP MCID = -2 mmHg (Wiles et al., 2017)

[d]Fasting blood glucose = ≥ 1 mmol/L (Hordern et al., 2008; UK Prospective Diabetes Study Group, 1998)

5.3.3 Physical Function Measures

Physical function outcome measures are shown in Table 7. 6MWT scores improved in 10 participants with four participants improving their distance by at least 27

m compared to baseline (Minimal Detectable Change (MDC) = 27 m) (Alfonso-Rosa et al., 2013). Time to complete the TUG test decreased in 11 participants with six participants decreasing their time by at least one second (MDC = 1 sec) (Alfonso-Rosa et al., 2013). All participants showed improvements in upper and lower extremity strength. Seven participants increased repetitions performed during the CST and arm curl test by the MDC cut off (CST MDC = 3.3 repetitions, arm curl test MDC = 2.3 repetitions) (Alfonso-Rosa et al., 2013; Hesseberg et al., 2015). It is important to note that no serious adverse events or minor injuries occurred during any of the eight-week GFAL-D program sessions. Some participants did experience delayed onset muscle soreness; however, this discomfort did not prevent them from participation in the program or result in missed exercise sessions.

Table 7. Physical function pre- and post-GFAL-D intervention by study participant (n = 12).

	Pre-exercise						**Post-exercise**					
	6MWT (m)	**TUG (s)**	**CST (reps)**	**Arm curl test (reps)**	**Sit and reach (cm)**	**Back-scratch (cm)**	**6MWT (m)**	**TUG (s)**	**CST (reps)**	**Arm curl test (reps)**	**Sit and reach (cm)**	**Back-scratch (cm)**
1	406.9	7.63	11	17	0	18	516.6[a]	6.61[b]	17[c]	20[d]	0	17
2	379.5	9.35	10	12	0	31	425.2[a]	6.09[b]	16[c]	20[d]	0	17[f]
3	470.9	8.04	15	18	0	9	480.0	7.26	16	20	0	9
4	347.5	9.80	7	19	11	17	338.3	9.33	8	28[d]	8	13
5	489.2	6.73	15	24	0	-3	530.4[a]	5.04[b]	19[c]	26	0	-7
6	489.2	6.25	13	23	0	9	502.9	4.77[b]	20[c]	25	0	9
7	342.9	13.65	9	15	0	55	361.2	12.72	10	17	0	52
8	672.0	5.76	15	19	-8	0	685.0	4.44[b]	25[c]	29[d]	-7	0
9	690.4	6.03	16	20	0	23	690.4	5.11	19	21	-2	21
10	667.5	6.09	16	24	0	9	704.1[a]	5.96	27[c]	32[d]	-8[e]	15[f]

11	667.5	5.40	17	20	0	12	690.4	6.16	23[c]	27[d]	-9[e]	11
12	644.7	6.93	13	11	6.5	30	566.9	5.63 [b]	15	18[d]	8	22[f]

[a]6MWT MDC = 27 m (Alfonso-Rosa et al., 2013)

[b]TUG MDC = 1 sec (Alfonso-Rosa et al., 2013)

[c]CST MDC = 3.3 repetitions (Alfonso-Rosa et al., 2013)

[d]Arm Curl Test MDC = 2.3 repetitions (Hesseberg et al., 2015)

[e]Sit and Reach Test MDC = 6.0 cm (Hesseberg et al., 2015)

[f]Back Scratch Test MDC = 4.6 cm (Hesseberg et al., 2015)

5.3.4 Interviews

Eleven of the 12 participants completed all three interviews which were on average 45 minutes (range: 25-55 minutes). Three themes relating to T2D self-management with insight into the process of adopting 'healthful' behaviours emerged from the interviews. Figure 3 shows the three main themes and codes generated by the researchers. Interviews completed across three time points of the one-year study were analyzed as a group. Analyzing the interviews together was done with the intent to understand exercise participation over time, such as the factors influencing participants when they temporarily stopped exercise, started exercise again, the strategies they employed and their goals and reasons for motivation.

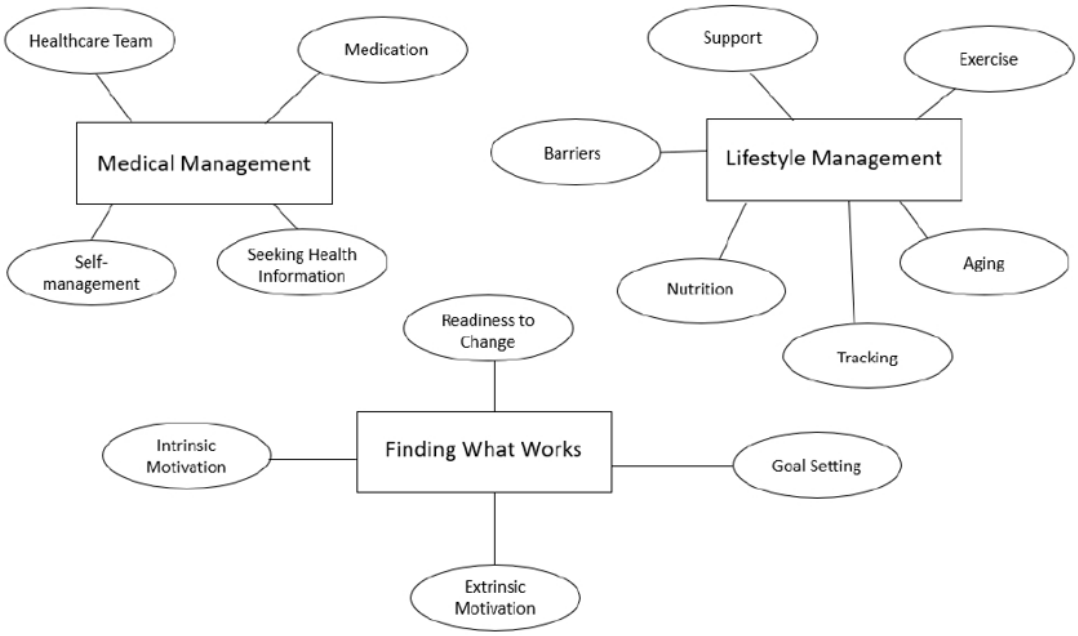

Figure 3. Thematic map showing the three main themes (rectangles) with associated codes (ovals).

Theme one: Medical management

Medical management captured participants' views about how they and their primary care provider monitor their health status. Participant stories began describing their experience of being diagnosed by their primary care provider during the one-month interview. "Well, it was no surprise because I had been prediabetic for quite a while" (P1). "I expected it in a way because my mother had it" (P3). The main role of the primary care provider was to prescribe diabetes medication and provide education about lowering blood glucose levels. "The doctor increased the dosage of the medicine" (P6). All but two participants were referred by their primary care provider to a dietitian when they were first diagnosed, which was discussed at the one-month interview. "The dietitian went over the foods I should be eating… looking at [my] carb count" (P10). However, primary care providers did not provide adequate education about the role of

exercise in the management of T2D. “I think the doctor said I had to get moving. She wanted me to move a lot, that’s all” (P10). There was an emphasis on lowering blood glucose levels among participants and participants described strategies for handling blood glucose swings. “I just do the finger prick” (P9). “Certainly, if I feel like my blood sugar’s probably not going great right now, I better go out for a walk after supper” (P5).

Despite the medical management received from primary care providers, participants were often seeking health information from other resources, which was discussed during the one-month interviews. “I started looking on the internet about my diabetes type 2… I contacted the Diabetes Association in Canada, and they sent me a lot of information” (P2). Other participants stated they specifically lacked an understanding about the role of exercise in managing T2D and were wanting more information. “I suppose in a magazine… it was some different exercises in there so I just, you know, a couple that I thought were helpful for me” (P4).

Theme two: Lifestyle management

T2D self-management mainly consisted of nutrition and exercise. Participants discussed challenges with maintaining or adopting new health behaviours throughout the one year. In general, participants emphasized nutrition when describing how they were managing their T2D and the changes that they’ve made prior to starting the GFAL-D program during the one-month interviews. “When I got diabetes, I stopped white bread… I don’t drink sodas. I do try to follow healthy eating” (P12). Participants mainly focused on carbohydrate consumption. “If I bring something new in the house, I look at how many carbs and fiber and then I’ll write on it” (P10).

Participants also described the physical activity and exercise that they were doing over the past year, which was highly variable among participants and throughout the one year. “You know, regular household chores like cutting the grass and shoveling the snow, that kind of thing” (P9). Contrarily, “somebody gave me a DVD, like exercises you just kind of do in the house. It takes about 20 minutes, I’m doing those” (P11), which she continued to do throughout the one year. However, participants main form of exercise consisted of walking outside. “I found exercises that I like, you know, this walking business. I really like walking” (P1). Only one participant regularly went to the gym since completing the program. “I keep a little calendar in my gym bag, and I write down what I’ve done and how long I’ve done it” (P10). However, most participants believed they should be doing more in terms of exercise participation, which was discussed at 6-months post-GFAL-D. “The walking is not enough. I know I should maybe do some balance and you know stretching and all those things” (P3). “I know I have to exercise and the weights and all that stuff” (P6).

Despite the belief of needing to exercise more, there were a wide range of barriers that were discussed throughout all time points. Lack of time was common. “Just only scheduling and working” (P8). Other reasons for lack of time were taking care of family. “I was trying to find time in my life where I could work it in” (P5). Another major challenge to participating in regular exercise included relying on the weather. “When it’s snowing like this and there’s ice, I don’t walk because I’m afraid to fall” (P11). Participants also mentioned finances and a lack of motivation as potential barriers. “I’m not having any income at the moment” (P9), whereas P6 stated, “sometimes I’m not interested enough.”

Participants expressed that social support was often needed to participate in exercise. “As far as exercise classes, much better with a friend because they keep you honest” (P1). Some participants needed an instructor to stay motivated. “Without an instructor I don’t do too much. So, I’ve always had an instructor” (P3).

Participants used various methods to track their progress regarding nutrition and exercise. P5 commented at the six-month interview how she has been monitoring her progress, “weighing myself once or twice a week to make sure I can maintain the weight loss.” For the avid walkers, counting steps was common, “now I do almost my 10,000 steps in my walk in the morning” (P10). The mobile health app, MyFitnessPal™, was introduced in the program as a potential method for tracking nutrition and exercise. Overall, participants were not interested in using the mobile health app. “I didn’t think it was appropriate to ask all the questions that they wanted to ask to register” (P9). Some participants started using the app but not regularly. “I would say I’m more trying to get back into it…sometimes I kind of peter off near the end of the day” (P5).

Theme three: Finding what works

Theme three captured participants’ readiness to change and motivation throughout the one year after completing the GFAL-D program. Participants expressed their goals in terms of engaging in regular physical activity and exercise. “I intend to walk every – five days, for at least 20 minutes. That’s my plan” (P3). “I want to get to where I’m doing exercises every morning before work” (P11).

A common goal among participants was lowering blood glucose levels and managing their T2D through lifestyle alone. “I will have to see my A1C, you know, go down a little bit more… that’s my goal” (P3). “My goal is to become free of the

medication" (P8). Although participants shared long-term and short-term goals, many noted relapses over the past year. "So, yeah there's about 10 pounds I've put on and then want to lose at six-months post-GFAL-D" (P5). At the 12-month interview, one participant described why he discontinued exercise. "I've been getting lazy" (P6).

Participants described extrinsic motivators to participating in exercise. Introjected regulation was depicted in the interviews through feelings of guilt. "I feel guilty if I don't do anything so every day in my spare time, I try to do something" (P2). Other participants described identified regulation, describing why improving their health was important. "So, as long as I'm healthy, I can do what I want… I can maintain my lifestyle. As long as I can skate with my grandkids" (P12).

Some participants achieved intrinsic motivation. "I just love being outside, you know, nature" (P9). Similarly, "you're enjoying nature, listening to a bit of music or just chit chatting with a friend" (P10). Others were able to maintain their activity levels by incorporating physical activity into their daily lived. "Mainly I try and work exercise into my everyday life while I'm doing other things. So, whenever I'm doing something social, I try and make sure we're going out for walks" (P5). One participant described how she incorporates physical activity while working from home 12-months post-GFAL-D, "during conference calls, I find that I'm standing now. I take them with the headset and like, pace kind of up and down so that I'm just not sitting all the time" (P11).

This study demonstrated clinical improvements after participating in eight-weeks of exercise in adults with T2D as well as explored long-term exercise adherence through participant interviews. This study highlights the potential for community programs with ongoing support for this population.

5.4 Discussion

This study reported positive changes among participants for waist circumference, fasting blood glucose, blood pressure and physical function after completing a supervised eight-week education and exercise program in adults with T2D. Additionally, motivation was explored through interviews with some participants achieving intrinsic motivation through adoption or maintenance of exercise.

Lack of time was a common barrier reported by participants during the interviews. HIIT is a more time efficient exercise protocol that may be beneficial when lack of time is cited as a barrier to exercise participation (Jabardo-Camprubí et al., 2020). An RCT examined the effects of HIIT in 23 women with T2D and reported statistically significant improvements in the following: A1C ($p<0.001$), systolic blood pressure ($p<0.001$), BMI ($p<0.05$) and waist circumference ($p<0.01$) (Alvarez et al., 2016). Increased pain and discomfort were also noted when participating in HIIT compared to moderate-intensity exercise (Jabardo-Camprubí et al., 2020) and therefore, it is important to consider enjoyment, satisfaction and motivation when engaging in an exercise program.

BMI was unchanged among participants completing the GFAL-D program. An RCT of 53 women with T2D completing an eight-week aerobic exercise program consisting of 30 minutes of moderate intensity three times per week reported within group improvements in BMI ($p=0.01$) (Motahari-Tabari et al., 2015). However, the participants caloric intake was controlled throughout the study (Motahari-Tabari et al., 2015), which likely contributed to reductions in BMI, as recent research supports caloric restriction alone significantly reduces BMI (Perry et al., 2020).

Only two participants achieved a clinically significant decrease in fasting blood glucose (≥ 1 mmol/L) (Hordern et al., 2008; UK Prospective Diabetes Study Group, 1998) after the eight-week program. In our study, participants' blood glucose levels were generally, well-controlled and therefore, significant changes were not expected. None of the participants were diagnosed with hyperglycemia (> 15 mmol/L) and eight participants had elevated fasting blood glucose levels (6.1-15 mmol/L) (UK Prospective Diabetes Study Group, 1998). More change would be expected if participants were considered to have uncontrolled fasting blood glucose levels. Similarly, an RCT examining a lifestyle intervention on glycemic control in adults with T2D reported mean baseline A1C of 6.65% and 6.34% at the 12-month follow up ($p=0.15$) (Johansen et al., 2017). As well, a systematic review consisting of 47 RCTs reported structured combined exercise interventions of more than 150 minutes per week were associated with a 0.89% decrease in A1C whereas structured exercise interventions of 150 minutes per week or less resulted in a 0.36% decrease in A1C (Umpierre et al., 2011). This is consistent with our findings as the GFAL-D program consisted of 120 minutes per week of structured combined exercise.

Overall, participants demonstrated improvements in physical function. Our findings are in accordance with previous research consisting of exercise interventions ranging from eight weeks to four months (Hsieh et al., 2016; Jamshidpour et al., 2019; Negri et al., 2010; Park & Lee, 2015). As well, a recent systematic review of RCTs examined the effects of exercise on physical function and glycemic control (Janssen & Connelly, 2021). Statistically significant improvements in 6MWT and 30-second CST scores were reported ($p<0.05$), however, nonsignificant changes were observed in TUG

scores (Janssen & Connelly, 2021). Though, there remains to be no standardized or optimal exercise program that maximize improvements in physical function and studies vary in duration, frequency, intensity, and type of exercise. A meta-analysis revealed that an exercise duration of eight weeks was sufficient to cause significant improvements in strength despite differences in exercise frequency, intensity, and type (Silva et al., 2014). Improvements in strength and endurance can be achieved in a relatively short time frame and may help to improve motivation and exercise adherence (Higgs et al., 2016).

Theme one described the medical management of T2D, which largely consisted of medication prescription and a dietitian referral to lower blood glucose levels. Participants were uninformed about the role of exercise intervention for T2D management. Similarly, a survey study of 159 general practitioners determined that exercise counseling was low and only 17% of general practitioners had received training in exercise counseling (Joyce & O'Tuathaigh, 2014). As well, interviews and observations from a case study revealed the usefulness of a health professional education program for nurses emphasizing exercise prescription, however, challenges regarding exercise uptake and adherence were reported due to a lack of training in motivational interviewing (Matthews et al., 2017). Meanwhile, physiotherapists are well-trained to provide exercise education and prescription while incorporating motivational interviewing to their patients with T2D but are currently not included in the primary healthcare team for T2D management.

Theme two explored T2D self-management highlighting nutrition and exercise while expressing barriers to exercise, the influence of social support, and tracking progress. Our findings are consistent with previous research on barriers to exercise

participation and the need for social support (Beverly & Wray, 2010; Casey et al., 2010; Ferrand et al., 2008; Tulloch et al., 2013). Only two of the 12 participants used the mobile health app MyFitnessPal™ during the study, which both had used prior to enrolling. Uptake of MyFitnessPal™ was low due to lack of interest, not wanting to disclose personal information and difficult to use. An RCT examined weight loss using MyFitnessPal™ over six months in 212 individuals with a BMI ≥ 25 kg/m^2 and mean age of 43.4 years (Laing et al., 2014). Despite logins decreasing over the six-month period and nonsignificant changes in weight loss compared to controls at six-months, participants were more aware of their food choices and were satisfied with using the app (Laing et al., 2014). In comparison, an older demographic (mean age = 64.2 years) and lack of desire to monitor or restrict caloric intake may have contributed to disuse in using a mobile health app in our study.

Goal setting, extrinsic, and intrinsic motivation towards exercise participation were elaborated on in theme three. Unsurprisingly, goals consisted of engaging in regular exercise, losing weight, and discontinuing diabetes medication. A hermeneutic analysis of diabetes educators' experiences with goal setting strategies for patients with T2D reported four themes: applying theoretical-practical principles when setting goals, identifying idealistic-realistic expectations, creating patient-educator-centered plans, and readying-living with goal setting (Fleming et al., 2013). Physiotherapists are able to address all goals identified by the participants in this study. Incorporation of physiotherapists into the healthcare team for T2D management can help support patients in identifying and meeting realistic goals in adopting new health behaviours.

Motivation varied across participants. However, an RCT consisting of six-sessions of motivational support and information on diabetes, exercise, nutrition, and behaviour change in 307 participants diagnosed with prediabetes reported significant improvements in motivation, self-efficacy, healthy eating, and physical activity after one year (Critchley et al., 2012). Although our program also consisted of an educational component, Critchley et al. (2012) attributed significant findings to the emphasis on increasing participants' knowledge of diabetes and focusing on positive thought. As well, the population consisted of individuals with prediabetes, which may be more inclined to adopt new health behaviours as opposed to patients with long-standing T2D.

5.4.1 Limitations

Our study had limitations to acknowledge. First, our sample size was small. Although we captured a rich description of the emerged themes, a larger sample size would have been more confirmative regarding changes to fasting blood glucose, blood pressure, anthropometric measures, and physical function. Second, although participants were not engaging in regular physical activity in the previous month, eight participants had been involved in supervised group exercise programs in the past. The findings represent a group of participants more likely to engage in regular physical activity and exercise. And third, the study location in a midsized city in Ontario, Canada, allowed for easy access to community programs and facilities.

5.4.2 Conclusion

In summary, this study explored how a physiotherapist-led supervised exercise and education program for adults with T2D influences fasting blood glucose levels, blood pressure, BMI, waist circumference and motivation for exercise adherence.

Overall, there were positive changes in waist circumference, systolic blood pressure, and physical function among study participants. Participant interviews revealed insight into how adults with T2D manage their condition from both a medical and lifestyle standpoint. This study highlights the potential impact of incorporating the physiotherapy profession into the interdisciplinary health team for patients with T2D, as physiotherapists are able to prescribe exercise, provide education, and assess motivation, as well as empower patients to set realistic patient-centered goals and adopt new health behaviours.

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Chapter 6

General Discussion

The aim of the research presented in these three studies was to highlight a new opportunity for physiotherapy caseload expansion to include T2D as a primary condition for referral. We first gathered what and how T2D content was being taught in entry-to-practice physiotherapy programs in Canada. We then explored how currently practicing physiotherapists perceived T2D and their perspectives on playing a primary care role in T2D management. Participants supported the idea of the uptake of T2D as a primary condition for referral and advocated that physiotherapy can provide education, exercise prescription and supervision, and support behaviour change for exercise adherence. Lastly, we investigated the effect of a physiotherapist-led group education and exercise program on clinical outcome measures, physical function and motivation for people living with T2D as a potential physiotherapy intervention. T2D is a condition often seen in physiotherapy practice, with 80% of patients being referred to outpatient physiotherapy either diagnosed with diabetes (type 1 or type 2), prediabetes, or have risk factors for T2D (Harris-Hayes et al., 2020; Kirkness et al., 2008). However, studies one and two revealed that T2D is viewed as a co-morbidity; a condition to consider during assessment and treatment but not a condition physiotherapists directly help to manage. This premise is supported by limited research regarding primary management of T2D by physiotherapists. Current physiotherapy research focuses on treatment and management of diabetes complications (Davies et al., 2015; Hebenton et al., 2019; Jeong et al., 2021; Miller et al., 2021) or T2D as a co-morbidity (Amusat et al., 2014) rather than early intervention prior to the development of diabetes complications. Dean et al. (2016)

advocate for the expansion of the physiotherapy profession to include a primary role in T2D management. Physiotherapists can have a positive impact on the prevention and management of noncommunicable diseases more broadly, including cardiovascular disease, hypertension, obesity, and T2D through health promotion practices and implementation of behaviour change (Dean et al., 2016). To advance the physiotherapy profession to evolve with the health care needs of the population, entry-to-practice programs need to integrate health promotion practices and competencies in keeping with the epidemiological trend of the increasing prevalence of noncommunicable diseases (Dean et al., 2016).

Taken together, the novel contributions of this series of research studies identify a gap in care for the management of T2D. Physiotherapists can provide a thorough subjective and objective assessment followed by tailored exercise education, prescription, and monitoring as well as behaviour change techniques. Incorporation of physiotherapists into T2D care could optimize health outcomes including blood glucose levels, blood pressure, BMI, waist circumference and physical function in people living with T2D by promoting physical activity and exercise participation, as evidenced by the findings of the education and supervised exercise study presented in this dissertation.

Three studies were conducted to address my research questions. The first study described educators' perspectives and curriculum content about what and how T2D content is taught in entry-to-practice physiotherapy programs across Canada. Then, in study two, we explored physiotherapists' perspectives using telephone interviews on the interest and feasibility of including T2D as a primary condition for referral in clinical and community settings. To illustrate a potential physiotherapy intervention for

community-dwelling adults living with T2D, study three investigated the effects of an eight-week supervised education and exercise program led by a physiotherapist on clinical outcomes, including physical function and motivation for exercise continuation. The aim was to reveal what physiotherapists and physiotherapy students know and understand about T2D, competencies to be developed, challenges for integration of T2D into curriculum as well as practice, and to raise awareness about how physiotherapists can play a vital role in T2D management through exercise counseling and prescription.

The first study presented in my dissertation sought to explore and describe the approaches to the teaching and learning of T2D content in entry-to-practice physiotherapy programs across Canada. An online survey sent to Program Chairs of the 15 physiotherapy programs in Canada was provided to their faculty or clinical instructors assigned to teach T2D content, or faculty members knowledgeable about the T2D content in the program curriculum. Seven of the 10 survey respondents who returned a completed online survey agreed to a subsequent one-on-one telephone interview. From the survey data, case studies and didactic lectures were the predominant delivery methods for T2D content. All programs included some curriculum devoted to T2D. T2D content was integrated into musculoskeletal, neurological, and cardiorespiratory courses within physiotherapy curriculum, and topics included exercise prescription, diabetes complications, nutrition to support blood glucose control, weight management, blood glucose levels, pathophysiology, and relevant anatomy. Subjectively, four of the 10 participants responded “yes” and six responded “no” when asked whether adequate time was spent on T2D in the current curriculum. Despite conflicting opinions, nine of the 10

participants “strongly agreed” or “agreed” that T2D was an essential condition taught in the curriculum.

Findings from study one indicated that educators acknowledged the relevance of T2D content in academic curricula and the need for integrating T2D content in teaching related to musculoskeletal, neurological, and cardiorespiratory physiotherapy. Educators noted incorporation of T2D as a co-morbidity to enhance complexity of clinical case studies for student learning and assessment. Interviews revealed that T2D is not a focus compared to other conditions taught in the current curriculum and cited lack of time in an already ‘busy’ curriculum as a barrier to expansion of T2D content in physiotherapy education. Our interpretations of the survey and interview findings revealed a potential gap between the trends in prevalence of T2D in the population and entry-to-practice curriculum guidelines. This finding aligns with a previous study reporting lack of confidence in providing care for people with T2D by physiotherapists, calling for future research to review physiotherapy training at the entry-to-practice level and continuing educational opportunities (Doehring et al., 2016). Eight of 10 participants reported less than five hours of T2D instruction and six responded that not enough time was devoted to T2D. Faculty members and clinical instructors often taught one course and therefore, their awareness of T2D content in other courses may be limited, particularly for programs that were structured around the three pillars of physiotherapy practice. Additionally, exercise and diabetes complications were the most common topics taught pertaining to T2D. This is supported in the literature which emphasizes the role of exercise in T2D management (Balducci et al., 2010; Chudyk & Petrella, 2011; Liu et al., 2019; Liubaoerjijin et al., 2016; Sigal et al., 2007; Tomas-Carus et al., 2016) and the

expertise of physiotherapists to prescribe safe and scaled exercise for people with diabetes complications (Ahmad et al., 2019; Davies et al., 2015; Hebenton et al., 2019; Jeong et al., 2021; Miller et al., 2021).

As health care professionals, entry-to-practice physiotherapists are expected to be knowledgeable about the etiology, pathophysiology, clinical signs and symptoms, differential diagnoses, prognosis, current physiotherapy management, and basic non-physiotherapy interventions for T2D (CCPUP, 2019). Students in entry-to-practice physiotherapy programs would benefit from further integration of T2D content in curricula pertaining to T2D-specific counseling and in relation to behaviour change and motivational interviewing. Entry-to-practice physiotherapy programs implement approaches to behaviour change; assessing stages of behaviour change and patient motivation, supporting change, and having difficult conversations with patients regarding lifestyle (CCPUP, 2019). Approaches to behaviour change and motivational interviewing are effective strategies for physiotherapists to promote physical activity and exercise in their patients (Nijs et al., 2020; Nooijen et al., 2016; Quick et al., 2020) and this skillset possessed by physiotherapists could be translated to help in the management of T2D. Behaviour change strategies and motivational interviewing are effective tools to improve the metabolic profile of T2D and encourage physical activity and exercise (Kidanu Berhe, et al., 2020; Selçuk-Tosun & Zincir, 2019; Woodard et al., 2022). The novel contributions from our study acknowledge that entry-to-practice physiotherapy programs have general knowledge and tools to manage patients with chronic disease, but more specific content (e.g., blood glucose levels) regarding T2D through education, implementation of safe and therapeutic exercise following the diabetes activity

guidelines (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018) and assessing and monitoring behaviour change. However, our findings suggest that there may be disconnect between the expectations of T2D in the curriculum and what was currently being taught according to CCPUP (2019).

As lack of time was a barrier for further integration of T2D content in physiotherapy curricula, one potential solution suggested was the development of continuing education and training for physiotherapists for the assessment and treatment for patients with T2D. The purpose of post-graduate training is to develop new skills and competencies and keep up to date with new practices (Ahuja, 2011). Post-graduate education and training has been shown to increase confidence and encourage therapeutic relationships (Gunn & Goding, 2009). Additional education and training for the management of T2D by physiotherapists could be beneficial and address the knowledge-to-practice gap in the current literature (Doehring et al., 2016). As evidenced by findings from study two, direct management of T2D is not part of current physiotherapy practice. Current physiotherapy curriculum needs to reflect current practice and therefore, promotion of the existing skills and knowledge of physiotherapists to receive T2D as a condition for referral is needed.

The second study described physiotherapists' experiences treating patients with T2D and explored physiotherapists' perspectives for the uptake of T2D as a primary condition for referral. Participants commented on the lack of awareness of physiotherapy by physicians, physiotherapists, and patients themselves on the impact physiotherapists can have pertaining to exercise counseling and participation. This is consistent with previous literature where one study surveyed 280 physicians and reported 75% were

aware of physiotherapy's scope of practice but only 11% often referred patients to physiotherapy (Al-Eisa et al., 2016). Another survey study investigated the awareness of physiotherapy among medical residents (Abichandani & Radia, 2013). Musculoskeletal and sport physiotherapy were the most well known (97.22% and 93.80%, respectively), with cardiovascular, obesity, and community-based rehabilitation among the least well known (68.8%, 67.7%, and 64.40%, respectively) (Abichandani & Radia, 2013). Although there was some awareness of physiotherapy for the management of obesity among medical residents, it is not common practice for physicians to refer patients to physiotherapy for management of obesity. Lack of referrals for T2D or people at risk of developing T2D may be, in part, due to patients not having subjective complaints or symptoms (Mangyo, 2015); this finding reflects the historical role of physiotherapy for treating joint and muscle pain and injuries (Dean et al., 2016). Study participants subjectively stated that T2D is not front of mind for patients when they have multiple comorbid conditions and therefore, there appeared to be a lack of urgency to manage the condition. Exercise counseling by other health care professionals is limited. Health care professionals can obtain additional training in T2D as certified diabetes educators, which is predominantly nurses, dietitians, and pharmacists in the current literature (Burke et al., 2014; Valentine et al., 2003). However, according to The Canadian Diabetes Educator Certification Board competency profile, candidates are required to have a general understanding about physical activity recommendations, benefits and risks of physical activity, and strategies to manage the effects of physical activity (CDEBC, 2019). There is a lack of expertise in exercise counseling among clinicians currently involved in T2D management (CDEBC, 2019); the addition of physiotherapists with this expertise may

address this gap as members of the health care team to provide patients with T2D safe, effective, and tailored exercise programming while considering additional ailments or subjective complaints. In addition to the lack of awareness of the physiotherapy profession, participants detailed accessibility and funding issues ongoing in the Canadian healthcare system as another barrier for physiotherapy integration into T2D management.

Physiotherapists could help reduce healthcare costs by decreasing the need for medications, diagnostic testing, and surgeries through promotion of physical activity. In 2009, direct and indirect healthcare costs of noncommunicable diseases secondary to physical inactivity were 6.8 billion dollars in Canada, representing 3.7% of all healthcare costs (Janssen, 2012). Of the seven noncommunicable diseases (i.e., coronary artery disease, stroke, hypertension, colon cancer, breast cancer, T2D, and osteoporosis) analyzed in the meta-analysis, T2D was the second most expensive noncommunicable disease for the Canadian healthcare system with 1.4 billion dollars in health care costs (Janssen, 2012). Inclusion of physiotherapists in the health care team for T2D management could ameliorate the secondary impairments of adults with T2D (i.e., amputation, cardiovascular disease, peripheral neuropathy) thereby improving function, mobility, and independence, as well as decrease healthcare costs. Physiotherapists interviewed in study two noted one-on-one sessions and supervised group exercise could provide an opportunity for patients with T2D to receive exercise counseling and prescription. A systematic review and meta-analysis of eight studies reported that physiotherapist-led physical activity interventions improved physical activity in adults at risk of developing noncommunicable diseases in private practice, primary care, and

outpatient settings short-term (Kunstler et al., 2018). Implementation of physical activity and exercise promotion by physiotherapists could be incorporated in the diabetes education centers or through referrals by physicians, nurses, or nurse diabetes educators. Although nutrition and exercise are both essential for T2D self-management (Balk et al., 2015; Greaves et al., 2011; Unick et al., 2011), studies two and three revealed the recognition of dietitians in the management of T2D, but physiotherapists, as exercise specialists, were not recognized as valuable clinicians.

Challenges persist for the addition of physiotherapists in the current model of care for people with T2D, including funding and awareness of the physiotherapy scope of practice by other primary health care providers. Since T2D is a known risk factor for cardiovascular disease, there is a high proportion of patients entering cardiac rehabilitation programs with T2D (Forhan et al., 2013); well-established group exercise programming designed and run by physiotherapists. Moreover, non-adherence to cardiac rehabilitation programs for patients with T2D and obesity was 59%, compared to 44% in patients without obesity and T2D (Forhan et al., 2013). Similarly, women with T2D were less likely to complete a cardiac rehabilitation program ($p<0.0001$), return for a one-year follow up ($p<0.0001$), and maintain cardiorespiratory fitness at one-year ($p=0.0009$) compared to women without T2D participating in a cardiac rehabilitation program (Armstrong et al., 2014). Although cardiac rehabilitation programs result in significant reductions in mortality and hospitalization in patients with T2D (Armstrong et al., 2015), patients with T2D may be grouped into cardiac rehabilitation programs, and therefore not receiving care specific for T2D or seeking care after the development of its complications. Programs designed specifically for patients with T2D encompassing

behaviour change, may help to improve adherence rates and provide education specific to T2D. Cardiac rehabilitation programs that include people with T2D and cardiovascular complications, along with other complications of T2D including the treatment of lower limb amputations (Miller et al., 2021), peripheral neuropathy (Davies et al., 2015), and stroke (An & Shaughnessy, 2011) that are managed by physiotherapists supports the concept that prevention through physical activity and exercise is not a priority of the current Canadian healthcare system. Early physiotherapy intervention for health promotion and exercise counseling for people with T2D or prediabetes could reduce the development of secondary complications and premature mortality. However, challenges with the current funding model were reported by study two participants and therefore, limiting the role of physiotherapy and accessibility to physiotherapy for people with T2D.

Study participants noted that in their experiences, people with T2D are more likely to access publicly funded physiotherapy, which is supported by Connolly et al. (2000). Publicly funded physiotherapy has long wait times and participants were unsure if publicly funded physiotherapy would accept people with T2D as the primary condition since it is not common practice. Wait times of up to 140 days were reported in Ontario, Canada for publicly funded physiotherapy where 73% of patients had chronic health conditions (Passalent et al., 2009). Consideration for accessibility and funding is needed when promoting physiotherapy for people with T2D, when a higher proportion of people with T2D are of lower socioeconomic status (Connolly et al., 2000). One way to improve accessibility is managing the long wait times publicly funded physiotherapy currently face. Education on self-management would allow for fewer follow up sessions,

mandating attendance policies, and wait list audits were reported as potential solutions for reducing the long wait times seen in Ontario, Canada (Passalent et al., 2010). Other considerations for including T2D as a primary condition of referral to physiotherapy would be if T2D is recognized by extended health benefits when a reason for referral is required and whether automated referrals, as seen with dietitians in some communities, would overwhelm physiotherapists. As well, for people that are allotted a given amount of dollars as part of their extended health benefits, it is unclear whether people with T2D would use their insurance coverage towards physiotherapy.

Lack of awareness of the role physiotherapy can play in terms of exercise education and health promotion was noted by physiotherapists, other primary care providers (e.g., physicians, nurses), and study participants with T2D in study two. It was suggested in study two, theme one that physiotherapists need to educate other healthcare providers on their role in exercise prescription and health promotion so that primary care providers can provide referrals. Physiotherapists in Canada believe they do play a role in managing conditions associated with obesity, including T2D, through education, exercise, mobility training, and cardiorespiratory interventions (You et al., 2012). However, the study participants described managing obesity and T2D as co-morbidities and a reason for continuing to see physiotherapists, rather than the primary condition for which patients sought physiotherapy. The aim of this dissertation advocates for T2D to be the primary condition for referral even if patients with T2D do not have subjective complaints, injuries, or muscle or joint pain with the goal of improving or maintaining function, mobility, and independence, and reducing the risk of diabetes complications. Furthermore, physiotherapists can play a role in primary prevention through assessment

and monitoring risk factors for T2D in their patients (e.g., blood glucose levels indicating prediabetes, high BMI, abdominal obesity, physical inactivity, hypertension, diet) and designing exercise programs as needed (Harris-Hayes et al., 2020).

Before physiotherapists can expand their caseloads to include people living with T2D, physiotherapists need to be competent to provide T2D-specific education and interventions. Theme three described that in the absence of adequate curricula and competencies, post-graduate training in the regulation of blood glucose levels and behaviour change/motivational interviewing would be beneficial. Although post-graduate training is not mandatory in Canada to maintain a license with physiotherapy Colleges (French & Dowds, 2008), the number of available courses available to physiotherapists is extensive (CPA, 2022). Post-graduate training has impact, particularly when there have been changes to practice which can improve competence, autonomy, and confidence (French & Dowds, 2008). To our knowledge, the Ontario Physiotherapy Association (OPA) Wound Care Management Program is the only post-graduate training that contains T2D content in some capacity that is currently being offered (OPA, 2022). With numerous courses for physiotherapists to take, consideration on the interest and uptake of such a course is necessary. Another solution is to re-evaluate and optimize the T2D content already taught in entry-to-practice physiotherapy programs, described in study one. This would allow physiotherapists to perhaps make better connections to what they already know about T2D management through exercise and behaviour change. A qualitative study reported that the current two-year master's program in Canada is not adequate and often leads to students memorizing content to pass exams rather than promoting consolidation of concepts and problem solving

(Walton, 2020). The purpose of this dissertation is to bring awareness of T2D knowledge-base and practice in the physiotherapy profession and to advocate that physiotherapists have the foundational skills to help manage T2D from a physical activity and functional mobility perspective while recognizing further training may be necessary.

The third study evaluated the influence of a supervised education and exercise program (i.e., GFAL-D) for adults living with T2D and was led by a physiotherapy student. At the end of the 8-week program, BMI did not change among participants, however, seven participants saw clinically significant reductions in waist circumference by at least 2 cm, the MCID (Brennan et al., 2020), on final measure. Clinically significant reductions in systolic blood pressure were reported in eight participants (MCID = -2 mmHg) (Wiles et al., 2017) and two participants reported clinically significant reductions in self-reported fasting blood glucose (1 mmol/L) (Hordern et al., 2008; UK Prospective Diabetes Study Group, 1998). Notably all participants saw improvements in physical function, however in terms of clinical significance, four participants improved 6MWT scores by at least 27 m (MDC = 27 m) (Alfonso-Rosa et al., 2013), six participants improved TUG scores by at least 1 second (MDC = 1 sec) (Alfonso-Rosa et al., 2013), and seven participants improved in each of the strength testing measures by the MDC (30-second CST MDC = 3.3 repetitions; arm curl test MDC = 2.3 repetitions) (Alfonso-Rosa et al., 2013; Hesseberg et al., 2015).

Similar findings regarding body mass were reported in a meta-analysis of RCTs of exercise interventions for adults with T2D (Boulé et al., 2001). Exercise interventions were at least eight weeks in duration and consisted of either aerobic or resistance

training. Exercise interventions did not result in significant improvements in body mass among participants but did reduce A1C by 0.66% compared to non-exercise control groups (Boulé et al., 2001). Therefore, the benefits of exercise for T2D self-management are to manage blood glucose levels and reduce the risk of diabetes complications rather than as a means of weight loss (Akinci et al., 2018; Alvarez et al., 2016; Boulé et al., 2001; Lambers et al., 2008; Negri et al., 2010; Park & Lee, 2015; Tan et al., 2012; van Dijk et al., 2012; Yukio Asano et al., 2014). Reductions in BMI have been reported in interventions incorporating exercise and caloric restriction (Motahari-Tabari et al., 2015). Exercise interventions have also been associated with improved body composition without changing BMI, resulting in reductions in visceral adipose tissue and an increase in lean body mass, which are correlated with improved insulin sensitivity (Cuff et al., 2003; Maiorana et al., 2002; Tan et al., 2012). Direct measurements of body composition were beyond the scope of study three, however, participants observed changes in waist circumference, an outcome measure that can be performed in clinic to monitor changes in patients participating in exercise and an indicator of abdominal obesity.

Notably, only two participants observed clinically significant changes in self-reported fasting blood glucose. A meta-analysis reported further changes in A1C levels with combined exercise more than 150 minutes per week (-0.89%) compared to combined exercise less than 150 minutes per week (-0.36%) (Umpierre et al., 2011). This is an important education piece when providing patients with physical activity and exercise guidelines, which recommends at least 150 minutes of moderate-to-vigorous aerobic exercise per week and two to three resistance training sessions per week

(Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). A twice weekly education and exercise intervention consisting of 120 minutes of combined exercise per week is feasible and realistic in clinical practice and physiotherapists should educate and encourage their patients to participate in additional exercise and physical activity. All participants observed improvements in physical function using tests that physiotherapists are already knowledgeable of and trained to perform, which is supported by previous literature (Hsieh et al., 2016; Jamshidpour et al., 2019; Negri et al., 2010, Park & Lee, 2015). Study findings indicate that the supervised eight weeks of aerobic and resistance exercise was enough to improve strength and endurance in this group of individuals with T2D. Implementation of a physiotherapist-led exercise program that is eight-weeks in duration is feasible and may be a beneficial starting point, encouraging patients with T2D to maintain exercise after one year. The main finding of study three was that exercise effects on indicators associated with T2D were observable using non-invasive outcome measures, versus blood glucose levels, already utilized by physiotherapists to highlight that evidence-informed management of T2D is already within the physiotherapy scope of practice.

During scheduled interviews at one-, six- and 12-months over the year following completion of the GFAL-D intervention, participants described how they were managing their T2D. Management consisted of medication adherence, nutrition, exercise, and regular meetings with their primary care provider to monitor blood glucose levels, medication dosage, and diabetes complications. Participants did note the lack of exercise counseling provided by their primary care provider, which is supported by previous research (Joyce & O'Tuathaigh, 2014; Matthews et al., 2017), and may be due to lack of

time with patients and a lack of knowledge about effective and safe exercise. However, one position statement acknowledged an opportunity for physicians, particularly sport and exercise medicine physicians, to counsel on and prescribe exercise for people with noncommunicable diseases (Thornton et al., 2016). A recent RCT examined the effects of physiotherapy telerehabilitation on blood glucose, aerobic endurance, and strength in 50 patients with T2D (Duruturk & Özköslü, 2019). A1C (p=0.0), 6MWT scores (p=0.0), TUG (p=0.0), and 30-second CST (p=0.0) significantly improved after a six-week home-based exercise program prescribed by a physiotherapist (Duruturk & Özköslü, 2019). Physiotherapists would be a beneficial addition to the current health care team for T2D management. As mentioned in studies two and three; patients are often referred or seek services from a dietitian but lack support for engaging in physical activity and exercise. The addition of physiotherapy would address a current gap in practice and would allow for patients with T2D to have access and support with lifestyle-related self-management.

Participants in study three exhibited extrinsic and intrinsic motivation and described goals relating to T2D self-management. Goals consisted of losing weight, lowering blood glucose levels, and participating in regular exercise. Addressing a patients' motivation towards exercise can improve self-efficacy and support patients in adopting healthy behaviour changes (Critchley et al., 2012). Physiotherapists have training in behaviour change to help their patients set and achieve realistic goals and manage expectations (CCPUP, 2019). Knowledge of motivation, as described in the self-determination theory, can aide physiotherapists when providing education on the benefits of physical activity and exercise to shift their patients' motivation towards integrated and intrinsic motivation (McGrane et al., 2014; Ryan & Deci, 2000). An example of

integrating motivational strategies into physiotherapy practice was conducted by Chan et al. (2009), who reported that physiotherapists implementing autonomy-supportive behaviour for the rehabilitation of 115 patients that underwent ACL reconstruction surgery resulted in statistically significant improvements in autonomous motivation ($p<0.05$) and rehabilitation adherence ($p<0.05$) (Chan et al., 2009). Behaviour change strategies, assessment of motivation, goal setting, and education are tools physiotherapists can integrate into clinical practice to help shift a patients' motivation towards intrinsic motivation. As well, physiotherapists need to be creative when designing a treatment plan in collaboration with the patient to ensure the patient will find enjoyment and adhere to physical activity and/or exercise.

6.1 Implications for Physiotherapy Practice and Future Research

This dissertation provides evidence that the physiotherapy profession is well-positioned and needs to evolve to optimize care for people with T2D, as a prevalent noncommunicable disease. Future research should focus on primary and secondary prevention emphasizing weight management, increasing muscle volume, lowering blood glucose levels, and educating and coaching patients with T2D seeking preventive care from physiotherapists, rather than physiotherapists only considering T2D as a co-morbidity. When treating a person with T2D as the primary diagnosis, physiotherapists should be obtaining a thorough subjective and objective assessment (i.e., duration of T2D diagnosis, self-report fasting blood glucose levels, medication, current management, diabetes complications, readiness for behaviour change, level of motivation, availability of social supports, and measureable personal goals, functional mobility, current exercise tolerance). Prescribed interventions should focus on safely

progressing exercise, considering the volume of exercise, as a combination of type, intensity and frequency, that addresses function and mobility, following the physical activity and exercise guidelines for T2D (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018) to achieve patients' goals (e.g., weight loss, lowering blood glucose levels) (Janssen et al., 2022, in review). When designing an exercise program, it is important to consider diabetes complications (Agrawal et al., 2010; Davies et al., 2015; Timar et al., 2016; Ülger et al., 2018) as individuals with T2D may have different impairments resulting in different activity limitations and participation restrictions (World Health Organization, 2001). Additionally, physiotherapists should recognize their scope of practice and be able to identify the limits of their knowledge and competency to know when a referral to other health care professionals is warranted (CCPUP, 2019) including physicians, nurse diabetes educators, dietitians, and psychological support (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018).

Previous findings are available about the effects of physiotherapist-led exercise programs for adults with T2D. One prospective study consisting of supervised physiotherapist-led resistance training for 30 adults with T2D reported statistically significant improvements in insulin sensitivity ($p<0.0001$), A1C ($p<0.001$), and fasting blood glucose levels ($p<0.001$) (Misra et al., 2008). Notably, the intervention was 12 weeks in duration and study participants had an average baseline A1C of $7.72 \pm 0.47\%$ (Misra et al., 2008) compared to the eight-week GFAL-D program where participants had lower self-report fasting blood glucose levels at baseline. Another study investigated the effects of physiotherapeutic exercise (e.g., aerobic exercise, joint stabilization,

mobilization, stretching) for 25 adults with T2D (Lucha-López et al., 2012). Lucha-López et al. (2012) reported statistically significant improvements in cardiovascular risk ($p<0.05$) and pain ($p<0.05$). Moreover, supervised exercise interventions for adults with T2D are safe and effective (Higgs et al., 2016) and close monitoring is recommended for this patient population (Kluding et al., 2015). Future research should consider how to integrate and optimize physiotherapist-led exercise programs in clinical practice in Canada, using the GLA:D™ program for osteoarthritis as a frame of reference (GLA:D™ Canada, 2022).

However, prior to inclusion of T2D into physiotherapy caseloads, future research needs to focus on the academic and clinical curriculum, and competencies of physiotherapists. In addition to the study conducted by Doehring et al. (2016), which reported that physiotherapists in Canada lacked confidence in providing education on diabetes complications, weight management, blood glucose level control, and nutrition for their patients with T2D, previous research has identified T2D as a condition physiotherapists require further education and training. A survey study of 100 senior physiotherapists reported that physiotherapists were least comfortable prescribing exercise for people with obesity and T2D (Mohan et al., 2012). Only 26.78% (n=19) of respondents were confident providing patients with T2D a tailored exercise program (Mohan et al., 2012). Another survey study examining physical activity and exercise counseling by physiotherapists reported that physiotherapists were most comfortable providing education and counseling for patients with MSK injuries and least confident providing counseling for patients with T2D (O'Brien et al., 2020). This, along with findings from study one and two, suggest future research should focus on optimizing

integration of T2D content in entry-to-practice physiotherapy programs as well as developing and implementing continuing education for T2D.

A barrier for the uptake of T2D into physiotherapy caseloads is the exclusion of physiotherapists from the interdisciplinary health team for T2D and lack of awareness of physiotherapy by other health care professionals. Physicians, nurses, nurse practitioners, dietitians, pharmacists, those providing psychological support, and diabetes educators are currently involved in providing direct care to those with T2D (Clark et al., 2011; Greer et al., 2016; Ismail et al., 2004; Ohman-Strickland et al., 2008; Welch et al., 2010; Wolf et al., 2004). Health care providers may provide exercise counseling to their patients; however, the extent of counseling and knowledge of exercise is limited. For example, a case study investigated the effects of an education program containing an exercise counseling component implemented by nurses (Matthews et al., 2017). Nurses found exercise counseling difficult to implement in patient care, in part, due to a lack of training in motivational interviewing (Matthews et al., 2017). As well, there is a lack of training in exercise counseling among physicians (Joyce & O'Tuathaigh, 2014), making it difficult to provide adequate education on exercise to their patients with T2D. Therefore, future research needs to focus on analyzing the roles of the health care providers that are part of the health team for T2D management and examine the impact physiotherapists can have. Challenges within the belief and practice of physiotherapists themselves is the idea that education is not considered an intervention provided by physiotherapists given the hands-on nature of the profession.

Another barrier to physiotherapy integration into T2D management was the lack of referrals to physiotherapy services from physicians or other health care providers, as a

referral is often needed for extended health benefits by insurance companies. This is supported by findings from Al-Eisa et al. (2016), which reported that only 11% of 280 physicians surveyed frequently referred patients to physiotherapy. Physiotherapists need to advocate for the profession, which can include physiotherapists, as well as provincial and territorial Associations and Colleges. Despite recognition of physiotherapy for the management of T2D by the CPA (CPA, 2012), to our knowledge there have been no campaigns advocating for referrals to physiotherapy for T2D. Future research should examine the impact on education sessions provided by physiotherapists to other health care providers to promote referrals for patients for physical activity and exercise education, particularly for those with noncommunicable diseases.

Study two revealed potential barriers for the uptake of T2D by physiotherapists (Janssen et al., 2022, in review). Socioeconomic status, accessibility, and funding posed challenges that extend beyond this dissertation. Previous research has reported on the economic impact of physical inactivity on healthcare systems and the utilization of healthcare services due to physical inactivity and noncommunicable diseases (Janssen, 2012; Pratt et al., 2014; Sari, 2009). Moreover, up to 5 million deaths per year are due to physical inactivity globally and physical inactivity results in a 20-30% increased risk of mortality (WHO, 2022). Promotion of physical activity among people with noncommunicable diseases or who have risk factors for noncommunicable diseases is imperative in managing healthcare costs. Future research needs to consider alternative funding models and healthcare access barriers. Analyzing different models of care, such as incorporating physical activity and exercise promotion for T2D by physiotherapists is needed to evaluate its influence on healthcare costs in Canada.

6.2 Critical Analysis

Study one highlighted the need for optimal integration of T2D content in physiotherapy entry-to-practice programs. Dean et al. (2016) advocate for the physiotherapy profession to evolve to contribute to the prevention and management of noncommunicable diseases including T2D, heart disease, cancer, chronic lung disease, hypertension, stroke, and obesity. Dean et al. (2016) note that entry-to-practice physiotherapy programs varied in terms of aligning the curriculum with the increasing prevalence of noncommunicable diseases worldwide. One way to integrate T2D content in an already 'full' curriculum is to group T2D content with other chronic noncommunicable diseases. Although not discussed in detail, one educator reported that T2D content was included in a public health course. Inclusion of a course containing content on lifestyle-related noncommunicable diseases could provide students with the knowledge and skills on health promotion practices, prevention and management strategies, and behaviour change techniques. Additionally, T2D content could be integrated into behaviour change and motivational interviewing content through case studies or simulations. Incorporation of T2D in motivational interviewing content would allow students to practice asking powerful, open-ended questions to empower patients and clients to make healthy lifestyle changes, specifically through physical activity and exercise.

As evidenced in study two, continuing education was needed to be able to effectively care for patients with T2D, particularly in terms of monitoring blood glucose levels. Hypoglycemia, defined as ≤ 3.9 mmol/L, is a period of abnormally low blood glucose levels for people with T2D and taking sulfonylureas, glinides or insulin

(International Hypoglycaemia Study Group, 2015). Hypoglycemia is a serious event resulting in impaired brain functioning and symptoms including trembling, palpitations, nausea, sweating, confusion, vision changes, and dizziness (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; International Hypoglycaemia Study Group, 2015). The risk of a hypoglycemic event increases with exercise, as glucose utilization is increased post-exercise (International Hypoglycaemia Study Group, 2015). Treatment of hypoglycemia is ingesting 15 g of glucose, which can increase blood glucose levels by 2.1 mmol/L in 20 minutes and can include three packets of table sugar dissolved in water, five sugar cubes or 150 mL of juice or soft drink (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018). Therefore, when prescribing and monitoring exercise for patients with T2D, physiotherapists need to be knowledgeable of normal blood glucose levels and able to monitor changes with exercise, clinical signs and symptoms of hypoglycemia and treatment of hypoglycemia.

Considering the accessibility and funding barriers for the uptake of T2D by the physiotherapy profession, it is important to recognize individuals with T2D that would most benefit from physiotherapy services so as not to over burden physiotherapists. Adults recently diagnosed and/or recently prescribed medication for their T2D may benefit the most, as interviews from study two reported that individuals are more motivated to make lifestyle changes when they are first diagnosed. Previous literature suggests that one bout of exercise can significantly reduce blood glucose levels (Gillen et al., 2012; Honda et al., 2016). Educating patients with T2D on the role exercise can play in the management of blood glucose levels, even after a single bout, can help promote

the shift towards intrinsic motivation and encourage exercise and physical activity participation.

Lastly, it is important to consider how patients with T2D will be integrated into physiotherapy caseloads, recognizing lack of referrals by primary care providers, long wait times and the fee-for-service model in Ontario. Integration into family health teams would be optimal, providing patients with T2D effective care targeting lifestyle and medical management by a team of primary care providers. However, physiotherapists are underutilized in family health teams in Ontario and are predominately accessible through private health care (Dufour et al., 2014). As suggested in study two, partnerships with registered kinesiologists could be another solution to reduce wait times and costs. Registered kinesiologists have the training to provide care for clients with T2D through physical activity and exercise programming (Ontario Kinesiology Association, 2017).

The studies presented in this dissertation identified a gap in T2D care whereby physical activity and exercise counseling and participation are lacking. In the current healthcare team, exercise specialists are underutilized. Physiotherapists can fill this gap, although accessibility, funding and the fee-for-service model pose challenges. Perhaps other avenues such as incorporation of registered kinesiologists may be more cost-effective in certain settings.

6.3 Conclusion

The purpose of this dissertation was to highlight a knowledge-practice gap in relation to exercise education and prescription for adults living with T2D. Inclusion of physiotherapists in the healthcare team may be one potential solution. We aimed to review the current T2D content in entry-to-practice physiotherapy programs and explore

physiotherapists' confidence treating their patients with T2D and perspectives on the uptake of T2D as a primary condition for referral. Lastly, we examined a potential physiotherapy intervention for this patient population using physical function outcome measures already utilized by physiotherapists to track changes in function and mobility. Given the high prevalence of patients with T2D or risk factors for T2D seeking physiotherapy services, along with an aging population worldwide, this dissertation addresses an important topic about the need for the physiotherapy profession to evolve to accommodate patients with multimorbidity. The first study, utilizing an online survey and telephone interviews, found new information about the delivery and integration of T2D in physiotherapy curricula. T2D content is essential in physiotherapy curriculum despite varying perspectives on whether T2D content is adequate in current curricula. The second study described physiotherapists' experiences treating patients with T2D and perspectives on assessment and management of T2D as a primary condition for referral. Based on participant interviews, recommendations included one-on-one sessions with a physiotherapist and supervised physiotherapist-led group exercise programs for patients with T2D. However, accessibility, funding, and lack of training pose challenges for incorporating T2D into physiotherapy caseloads. Lastly, the third study investigating an eight-week supervised physiotherapist-led education and exercise program for adults with T2D suggested physiotherapists can monitor the effects of this type of intervention using self-reported fasting blood glucose, blood pressure, BMI, waist circumference and physical function tests (i.e., 6MWT, TUG, 30-second CST, arm curls, back scratch, sit-and-reach). Markedly, physiotherapists currently have the foundational knowledge and skills to conduct physical function, blood pressure and anthropometric measures.

However, additional training in measuring and monitoring blood glucose levels is needed to enhance confidence and competence. Participants were interviewed one-month, six-months, and 12-months after the program to understand motivation towards exercise continuation. Exercise education and prescription by healthcare providers for people diagnosed with T2D is currently lacking. Further research is needed to determine whether physiotherapists are well-positioned to provide direct care through education, exercise, and behaviour change for this patient population.

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Appendices

Appendix A: Ethics Approval for Study 1

Western Research

Date: 24 May 2019

To: Dr. Denise Connelly

Project ID: 114013

Study Title: A survey of type 2 diabetes care content in academic curriculum of Master of Physical Therapy programs across Canada.

Application Type: HSREB Initial Application

Review Type: Delegated

Meeting Date / Full Board Reporting Date: 04/Jun/2019

Date Approval Issued: 24/May/2019

REB Approval Expiry Date: 24/May/2020

Dear Dr. Denise Connelly

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Consent Form	Written Consent/Assent	16/May/2019	2

Curriculum Review_Collected Documents	Other Data Collection Instruments	15/Apr/2019	1
Curriculum Survey_Research Proposal	Protocol	17/May/2019	2
Email Script	Email Script	16/Apr/2019	1
End of Study Letter	End of Study Letter	15/Apr/2019	1
Interview_Focus Group Guide	Focus Group(s) Guide	15/Apr/2019	1
Interview_Focus Group Guide	Interview Guide	15/Apr/2019	1
Telephone Script	Telephone Script	16/Apr/2019	1

Documents Acknowledged:

Document Name	Document Type	Document Date	Document Version
Rationale References	References	16/Apr/2019	1

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.
The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Appendix B: Letter of Information and Consent for Study 1

Study Title: A survey of type 2 diabetes care content in academic curriculum of Master of Physical Therapy programs across Canada.

Principal Investigator
Dr. Denise Connelly, PT, PhD
Elborn College, Western University

Student Researcher
Sarah Janssen, MSc
Elborn College, Western University

I am a PhD student at Western University in the Department of Health and Rehabilitation Sciences. We are conducting a research study across Canada to survey the current curriculum on type 2 diabetes education and training in the Master of Physical Therapy program. The purpose of this study is to describe type 2 diabetes content and delivery methods in Canadian Physical Therapy entry-to-practice programs and to describe instructors' beliefs about how type 2 diabetes is taught.

Being invited for this study
All 15 universities with a Master of Physical Therapy program will be invited to participate in this study (Western University, University of Toronto, McMaster University, Queen's University, University of Ottawa, Dalhousie University, Université Laval, Université de Sherbrooke, Université de Montreal, Université du Québec à Chicoutimi, McGill University, University of British Columbia, University of Alberta, University of Saskatchewan and University of Manitoba). You are asked to participate in this research study, as a faculty member teaching a course that contains type 2 diabetes content in a Master of Physical Therapy program to help describe type 2 diabetes content and delivery methods in the current curriculum.

What will I do if I choose to be in this research study?
Participants are asked to complete this short survey, which will take approximately 10 minutes to complete. At the end of the survey you will be asked if you consent to be contacted via email to participate in a telephone interview to elaborate or clarify answers to the survey questions. The telephone interview will take approximately 40 minutes. Interviews will be audio recorded. Please note that email is not a secure form of communication.

What are the possible risks?
Possible risks include breach of privacy. Interview transcripts will be handled as carefully as possible. Data will only be accessed by the student researcher and Principal Investigator.

What are the possible benefits of me or for others?

Participants may not benefit from this study. Benefits to others may include providing quality education on type 2 diabetes care for students in the Physical Therapy entry-to-practice program.

Confidentiality
We will be collecting personal information including contact information and audio recordings. A study ID will be assigned to you and transcripts from audio recordings will contain the study ID and not the participant's name.

Memory sticks containing audio recordings will be stored in a locked cabinet in a locked office in Elborn College at Western University. Memory sticks will be stored for 7 years and permanently destroyed as per Western University's policy. Audio recordings will not contain personal information. Electronic data (questionnaires) will be anonymous, stored for 7 years on an institutional server, password protected, and other security and back-up measures will be in place. The electronic data will be stored for 7 years and permanently destroyed as per Western University's policy. Only the student researcher (Sarah Janssen) and Principal Investigator (Dr. Denise Connelly) will have access to the audio recordings and electronic data prior to de-identification.

Results of this study may be used in publications and presentations. Your study data will be handled as confidentially as possible. If results of this study are published or presented, personally identifiable information will not be used.

Financial Information
Participation in this study will not involve costs to you. You will not be paid for participating in this study.

What are my rights as a research participant?
Participation in this study is voluntary. You are not able to skip questions in the online survey. If you do not want to answer a question during the interview, we can skip to the next question. We can also take a break, continue at a later date or stop altogether. You may withdraw from this study at any time and you will not be penalized in any way. If you decide to withdraw during the interview, the researcher will ask you if the information already collected can be used.

Conflicts of Interest
There are no conflicts of interest to declare related to this study.

Who can I contact if I have questions or concerns about this research study?
If you have any questions about your rights as a participant, you can contact the following office at Western University:

The Office of Human Research Ethics
Western University

I consent ☐
I do not consent ☐ (skip to end of survey)

**consent form will be on the first page of the online questionnaire.*

Appendix C: Online Survey for Study 1

Online survey using Qualtrics®[XM]:

Professional Background:

Q1. What is your highest level of communication completed?
☐ Bachelor's
☐ MSc
☐ PhD
☐ MD

Q2. What is your highest level of physical therapy education?
☐ Bachelor's
☐ Master's

Q3. How many years of clinical experience do you have?
☐ <5
☐ 5-10
☐ 11-15
☐ 16-20
☐ >20

Q4. What is your main area of clinical practice?
☐ Cardiorespiratory
☐ Musculoskeletal
☐ Neurological
☐ Orthopedic
☐ Geriatric
☐ Women's health
☐ Other, please specify: _____

Q5. What is your role at your current institution?
☐ Part-time instructor
☐ Lecturer
☐ Assistant professor

Q6. How long have you taught at your current institution?
☐ <1
☐ 1-5
☐ 6-10
☐ >10

Q7. What is your primary area of instruction?
☐ Cardiorespiratory
☐ Musculoskeletal

☐ Neurological
☐ Orthopedic
☐ Geriatric
☐ Women's health
☐ Other, please specify: _____

Q8. Are you involved in type 2 diabetes research?
☐ Yes
☐ No (skip to Q10)

Q9. What area of type 2 diabetes do you study?
☐ Physiology
☐ Anatomy
☐ Metabolism
☐ Exercise
☐ Health service
☐ Other, please specify: _____

Type 2 Diabetes Content and Delivery Methods:

Q10. What courses do you currently teach that contain type 2 diabetes content?

Q11. What area of type 2 diabetes do you teach in your course(s)? (check all that apply)
☐ Anatomy
☐ Physiology
☐ Musculoskeletal
☐ Electrophysiological agents
☐ Neurological
☐ Cardiorespiratory
☐ Rehabilitation
☐ Other, please specify: _____

Q12. Which of the following topics do you cover with regards to type 2 diabetes content? (check all that apply)
☐ Exercise
☐ Nutrition
☐ Diabetic complications and co-morbidities
☐ Weight management
☐ Blood glucose control
☐ Other, please specify: _____

Q13. In what year of the Physical Therapy program is type 2 diabetes taught? (check all that apply)
☐ First year
☐ Second year

Q14. Approximately how many hours of type 2 diabetes instruction do students receive?
☐ <5
☐ 5-10
☐ >10

Q15. For the type 2 diabetes content that you teach, which of these delivery methods do you use? (check all that apply)
☐ Lecture
☐ Clinical skills lab
☐ Case studies
☐ Assignments
☐ Small group discussion
☐ Other, please specify: _____

Q16. Are there opportunities for students to apply type 2 diabetes knowledge in a hands-on or clinical setting?
☐ Yes
☐ No (skip to Q18)

Q17. Please describe.

Instructors' Beliefs

Q18. Do you feel that adequate time is devoted to type 2 diabetes education in the Physical Therapy program at your institution?
☐ Yes (skip to Q20)
☐ No

Q19. Why not?

Q20. How confident do you feel teaching type 2 diabetes content to students in the Physical Therapy program? (1=not confident, 5=very confident)
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Q21. How prepared do you think students are in applying type 2 diabetes knowledge in clinical settings once graduated? (1=not prepared, 5=very prepared)
☐ 1
☐ 2
☐ 3

☐ 4
☐ 5

Q22. To what extent do you agree type 2 diabetes is an integral part of what students should be learning in the Physical Therapy program?
☐ Strongly agree
☐ Agree
☐ Somewhat agree
☐ Neither agree nor disagree
☐ Somewhat disagree
☐ Disagree
☐ Strongly disagree

Phone interview:

**Participants redirected to second survey, requesting email addresses.*

Q23. Do you consent to be contacted via email to participate in a telephone interview to describe your beliefs about how type 2 diabetes is taught in Canadian Master of Physical Therapy entry-to-practice programs?
☐ I consent
☐ I do not consent (skip to end of survey)

Q24. Please provide your email address: (please note, email is not a secure form of communication)

End of survey

Appendix D: Interview Guide for First Interviews for Study 1

1. Tell me about your experience teaching courses on T2D care to entry-level physiotherapists.
2. What changes have you made to the courses you teach on T2D over time?
3. How do you know that students are capable to treat patients with T2D when they begin to practice?
4. How confident do you feel teaching physiotherapy students about T2D care?
5. Is there anything else you would like to add?

The following probing questions may be used:

1. How do you decide what required readings to add to the course? Are these readings changing from year-to-year?
2. Tell me more about _____ assignment that you assign to your students.
3. Tell me about any previous research experience on T2D.

Appendix E: Interview Guide for Second Interviews for Study 1

1. How do you decide what it is about T2D that you teach? How did you prioritize T2D in your course?
2. What clinical practice guidelines do you use to supplement T2D content? Tell me about the resources that you draw on when developing your T2D content.
3. How would you facilitate the student to translate T2D knowledge taught in the curriculum to the clinical setting?
4. What do you think students should do to better their understanding of conditions when there isn't enough time or space in the curriculum?
5. What role do you think PTs can play in the treatment and management of type 2 diabetes?
6. What innovations would you advocate for physiotherapists to assume a larger role in caring for people living with T2D? What are your thoughts are being apart of a DEC health team for this population for example?
7. What role do you think PTs can play in the primary prevention of type 2 diabetes? What are the skills and behaviours that PT students need to develop (whether its academic or clinical) in order to address primary prevention? (KSB – knowledge, skills and behaviours)
8. What aspects of behaviour change are taught in the curriculum? (i.e. lifestyle coaching, motivational interviewing)
9. What are the stigma or biases towards people living with type 2 diabetes held by PTs? How does the curriculum address societal stigma or biases towards people who develop T2D?

The following probing questions may be used:

1. What other conditions are at the same level/priority as T2D?
2. T2D is one way to layer into a case to make it more complex. What are other examples of layering on a case to make it more complex?

Appendix F: Copyright Release Form for Study 1

University of Toronto Press Author Copyright Agreement

AUTHOR(S): Janssen, Sarah; Connelly, Denise M.; Gillis, Heather

CORRESPONDENCE: Sarah Janssen, Health and Rehabilitation Sciences, Western University, 1201 Western Road London Ontario Canada N6A 1H1

The University of Toronto Press (UTP),), with its address at 5201 Dufferin St., Toronto, ON, M3H 5T8, and the Canadian Physiotherapy Association ("CPA") are pleased to have the privilege of publishing your contribution to Physiotherapy Canada (“the Journal”) entitled “Educators’ perspectives on the teaching, learning, and practice of type 2 diabetes content in physiotherapy programs across Canada”, containing text, notes, charts, graphics, illustrations, photos and other material (hereinafter referred to collectively as “the Contribution”).

1. UTP will copy-edit the Contribution on behalf of CPA. The Author(s) will be given an opportunity to read and request changes to proofs, but if they fail to return them by the date set on the proofs, production and publication may proceed without the Author(s)’s approval of proofs. In the event of disagreement, the CPA reserves the right to decide which proof changes to implement.
2. CPA may publish the Contribution pursuant to this agreement at its cost. CPA has the exclusive right to determine how the Contribution will appear in the Journal and elsewhere. Furthermore, CPA has the right in its sole discretion not to publish the Contribution. If it elects not to publish the Contribution, CPA shall so notify the Author(s) in writing whereupon this agreement is terminated and all rights assigned or transferred by the Author(s) to CPA shall revert to the Author(s).

3. Subject to this section, the Author(s) hereby assign to CPA the exclusive world rights to the Contribution in its present, or substantially its present, form. CPA hereby obtains the right to use the Contribution in any future publication, including, but not limited to, publication in electronic media, issued under its auspices and to authorize others, including reproduction rights organizations including but not limited to Access Copyright, electronic database providers such as Project MUSE, and publishers such as UTP, to do the same. The Author(s) hereby grant to CPA the non-exclusive right to create the Digital Object Identifier (“DOI”) for this Contribution and to deposit the DOI with CrossRef, the official DOI registration agency for scholarly and professional publications. The Author(s) agree to refer to CPA any requests to publish the Contribution or portion thereof. CPA may charge a standard fee for reprinting, the amount of this fee to be fixed by it from time to time. CPA will accede to any request by the Author(s) to use part or all of their Contribution in a larger work published under either Author(s)’s exclusive authorship or editorship without charge, provided that acknowledgment of its first appearance is made in a manner approved by CPA. The Author(s) hereby waive any claim for royalties arising from the use by CPA of their Contribution. With respect to the photos for which the Author(s) hold copyright included in the

Contribution, the Author(s) grant a licence to CPA to publish them as part of the Contribution and the Author(s) reserve the right to publish such photos otherwise than in association with the Contribution

4. The Author(s) warrant they have the right to enter this agreement and that permission to publish the

Contribution has not been previously assigned elsewhere. The Author(s) further warrant that the Contribution is original to them, except for any copyrighted material of others incorporated in it, and that the Author(s) will advise CPA and UTP of any material, either text, photo, or illustration, the rights for which are controlled by others. The Author(s) will obtain, before publication and at their expense, permission in writing from the owner of the copyright in that material for publication by CPA and any licensees thereof in perpetuity pursuant to this agreement, unless CPA and UTP release the Author(s) of such obligation in a particular instance. Copies of any such permission must be submitted to CPA and UTP for their files. The Author(s) further warrant that the Contribution contains no defamatory or otherwise unlawful matter and that publication of it in any format does not invade or infringe the privacy or personal rights of anyone. The Author(s) undertake that all statements in it purporting to be facts are true; and that they will advise CPA and UTP of any statements that might be construed as defamatory, tortious or otherwise unlawful. CPA and UTP may require substantive revision of the manuscript to avoid including material that may infringe rights or be defamatory or otherwise unlawful.

5. The Author(s) agree that in the event of any claim, action, or proceeding based on any alleged violation

of any representations, warranties or covenants of the Author(s), the Author(s) shall indemnify and hold harmless the CPA from any damages, costs or other losses arising from any such claim, action or proceeding, and the CPA shall have the right to defend the same through counsel of its own choosing. The Author(s) agree to pay all resulting damages, costs and other losses, except that this indemnity of

Author(s) shall not apply to any changes in the manuscript by the CPA that were not approved by the Author(s) in advance of publication, or to any material that the Author(s) had warned in writing the CPA in advance of publication might be construed as defamatory or otherwise unlawful. The CPA may settle any such claim as it deems fit.

6. The rights and obligations herein shall ensure to the benefit of and be binding upon the parties, their executors, administrators and permitted assigns.
7. The Author(s) may not assign this agreement without the prior written consent of the CPA.
8. The Author(s) understand that this agreement and the Author(s)' signatures attesting to it shall be in electronic format.

Appendix G: Ethics Approval for Study 2

Western Research

Date: 11 November 2020

To: Dr. Denise Connelly

Project ID: 116757

Study Title: Type 2 diabetes as a primary condition of referral for physiotherapy

Application Type: HSREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 01/Dec/2020

Date Approval Issued: 11/Nov/2020 09:25

REB Approval Expiry Date: 11/Nov/2021

Dear Dr. Denise Connelly

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Enewsletter ad	Recruitment Materials	03/Nov/2020	2
Study 3 Research Proposal_Sarah Janssen	Protocol	05/Nov/2020	2
Interview Guide	Interview Guide	05/Nov/2020	2

Email Script	Email Script	05/Nov/2020	2
Letter of information and consent	Written Consent/Assent	05/Nov/2020	2

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Appendix H: Letter of Information and Consent for Study 2

Study Title: Type 2 diabetes as a primary condition of referral for physiotherapy.

Principal Investigator
Dr. Denise Connelly, PT, PhD
Elborn College, Western University

Student Researcher
Sarah Janssen, MSc
Elborn College, Western University

I am a PhD student at Western University in the Department of Health and Rehabilitation Sciences. We are conducting a research study across Canada to gain insight on physiotherapy interventions for people living with type 2 diabetes. The purpose of this study is to describe the role of physiotherapy interventions for patients with type 2 diabetes and explore the opportunity for type 2 diabetes as a primary condition of referral in Canada.

Being invited for this study
All provinces and territories across Canada will be invited to participate in this study. You are asked to participate in this research study, as a currently practicing registered physiotherapist in a community or outpatient clinical setting, to provide your perceptions and experiences on physiotherapy as an intervention for people living with type 2 diabetes.

What will I do if I choose to be in this research study?
Participants are asked to complete a one-on-one telephone interview that will take approximately 40 minutes to complete. Interviews will be audio recorded. When scheduling a day and time for the interview, please note that email is not a secure form of communication.

What are the possible risks?
Possible risks include breach of privacy. Interview transcripts will be handled as carefully as possible. Data will only be accessed by the student researcher and Principal Investigator.

You do not waive any legal rights by signing the consent form.

What are the possible benefits of me or for others?
Participants may not benefit from this study. The anticipated benefits of this study are to optimize health care for people living with type 2 diabetes and help provide a wholistic approach to care.

Confidentiality

We will be collecting personal information including contact information and audio recordings. A study ID will be assigned to you and transcripts from audio recordings will contain the study ID and not the participant's name.

Memory sticks containing audio recordings will be encrypted and stored in a locked cabinet in a locked office in Elborn College at Western University. Memory sticks will be stored for 7 years and permanently destroyed as per Western University's policy. Audio recordings will not contain personal information. Only the student researcher (Sarah Janssen) and Principal Investigator (Dr. Denise Connelly) will have access to the audio recordings prior to de-identification. Signed consent forms will be printed and will be stored in a locked cabinet in a locked office in Elborn College at Western University. Emails containing signed consent forms will be permanently deleted. However, please note that email is not a secure form of communication.

Results of this study may be used in publications and presentations. Your study data will be handled as confidentially as possible. If results of this study are published or presented, personally identifiable information will not be used.

Financial Information
Participation in this study will not involve costs to you. You will not be paid for participating in this study.

What are my rights as a research participant?
Participation in this study is voluntary. If you do not want to answer a question during the interview, we can skip to the next question. We can also take a break, continue at a later date or stop altogether. You may withdraw from this study at any time, and you will not be penalized in any way. If you decide to withdraw during the interview, the researcher will ask you if the information already collected can be used.

Conflicts of Interest
There are no conflicts of interest to declare related to this study.

Who can I contact if I have questions or concerns about this research study?
If you have any questions about your rights as a participant, you can contact the following office at Western University:

The Office of Human Research Ethics
Western University

Consent
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form.

_____
Participant's Name (printed)

_____ _____

Participant's Signature Date

My signature means that I have explained the study to the participant named above. I have answered all questions.

_____
Name of person obtaining consent (printed)

_____ _____

Person obtaining consent signature Date

Appendix I: Interview Guide for Study 2

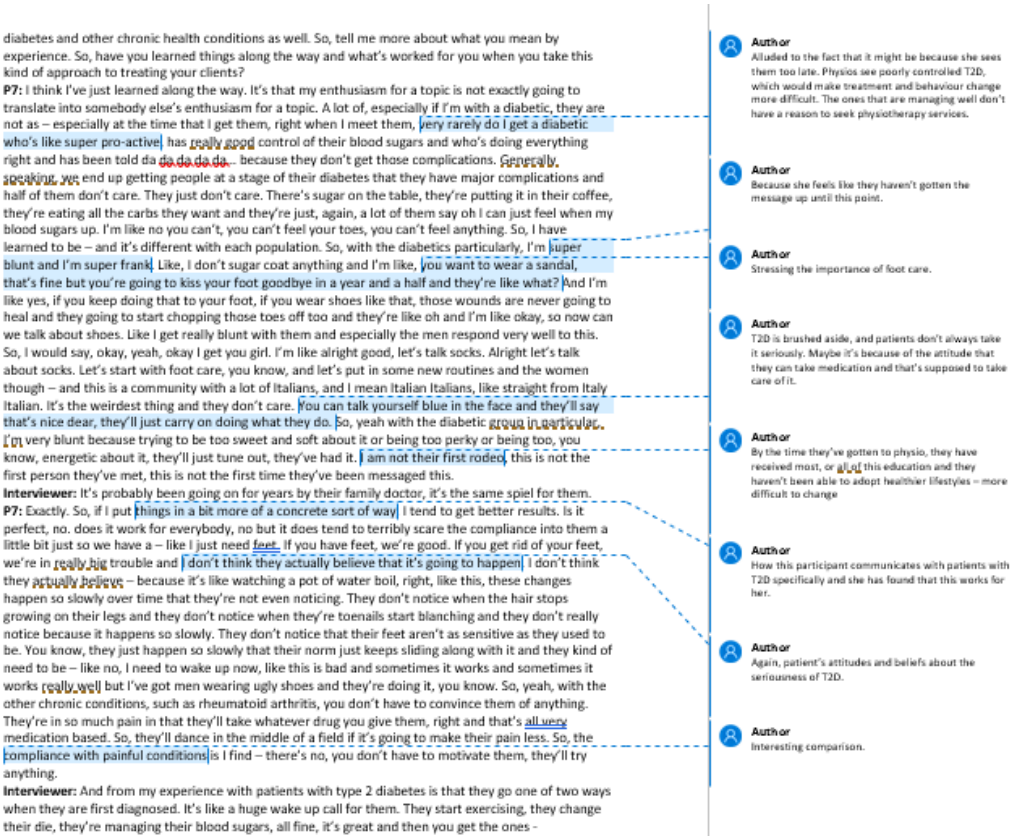
1. What is the highest level of physiotherapy education you have completed? What post grad education or training have you received?
2. How many years have you been practicing as a registered physiotherapist?
3. What physiotherapy settings have you worked in? What setting of physiotherapy are you currently working in?
4. What is your main area of practice?
5. Tell me about your awareness on opportunities and current literature for physiotherapy case load expansion.
6. Tell me about your experience treating patients with chronic conditions?
7. What are your perceptions on expanding caseloads to include type 2 diabetes as a primary condition of referral?
8. Tell me about your experience treating patients with type 2 diabetes?
9. Tell me about a time where you treated a patient who came in with whatever injury or issue, but they also had type 2 diabetes. So, how did you address it, if you addressed it?
10. Do patients react differently when you talk about lifestyle management and changes to their exercise because I feel like that could sometimes be a sensitive topic maybe. Just wondering if you've had an experience where the patient reacted well and was open minded versus a patient that was a little bit more closed off about receiving education about this?
11. And what are other challenges, if any, when it comes to treating patients that have type 2 diabetes?
12. What education and/or training did you receive for chronic health conditions?
13. How do you address patients who have risk factors for developing type 2 diabetes?
14. What are your thoughts on the accessibility of patients with type 2 diabetes referred to physiotherapy with type 2 diabetes as their primary condition?
15. Is there anything you would like to add?

The following probing questions may be used:

1. Do you commonly or on occasion treat patients with their chronic condition as a primary condition of referral? Tell me more about that.
2. What would/does an assessment or treatment session look like for a patient coming in with type 2 diabetes as their condition of referral?
3. How are patients with type 2 diabetes currently being treated in your community?
4. How do you promote better health outcomes in patients with type 2 diabetes?
5. What intervention strategies fall within the scope of physiotherapy practice?
6. What resources/referrals do you provide your patients with type 2 diabetes?
7. What is your knowledge base in behaviour change/motivational interviewing/lifestyle coaching?
8. How do you implement behaviour change/motivational interviewing/lifestyle coaching into your practice?
9. What education/training/mentorship have you received regarding type 2 diabetes?
10. What barriers are there from the point of referral?

11. What are the funding barriers for referring patients with type 2 diabetes to physiotherapy?
12. What does the referral process look like?
13. What are your perceptions on the stakeholders (e.g., physicians, nurse practitioners, diabetes educations, associations, patients with type 2 diabetes) awareness on the role of physiotherapy as an intervention for type 2 diabetes?

Appendix J: Sample of a Reflexive Memo for Study 2



diabetes and other chronic health conditions as well. So, tell me more about what you mean by experience. So, have you learned things along the way and what's worked for you when you take this kind of approach to treating your clients?

P7: I think I've just learned along the way. It's that my enthusiasm for a topic is not exactly going to translate into somebody else's enthusiasm for a topic. A lot of, especially if I'm with a diabetic, they are not as – especially at the time that I get them, right when I meet them, very rarely do I get a diabetic who's like super pro-active, has really good control of their blood sugars and who's doing everything right and has been told da da da da da – because they don't get those complications. Generally, speaking, we end up getting people at a stage of their diabetes that they have major complications and half of them don't care. They just don't care. There's sugar on the table, they're putting it in their coffee, they're eating all the carbs they want and they're just, again, a lot of them say oh I can just feel when my blood sugars up. I'm like no you can't, you can't feel your toes, you can't feel anything. So, I have learned to be – and it's different with each population. So, with the diabetics particularly, I'm super blunt and I'm super frank. Like, I don't sugar coat anything and I'm like, you want to wear a sandal, that's fine but you're going to kiss your foot goodbye in a year and a half and they're like what? And I'm like yes, if you keep doing that to your foot, if you wear shoes like that, those wounds are never going to heal and they going to start chopping those toes off too and they're like oh and I'm like okay, so now can we talk about shoes. Like I get really blunt with them and especially the men respond very well to this. So, I would say, okay, yeah, okay I get you girl. I'm like alright good, let's talk socks. Alright let's talk about socks. Let's start with foot care, you know, and let's put in some new routines and the women though – and this is a community with a lot of Italians, and I mean Italian Italians, like straight from Italy Italian. It's the weirdest thing and they don't care. You can talk yourself blue in the face and they'll say that's nice dear, they'll just carry on doing what they do. So, yeah with the diabetic group in particular, I'm very blunt because trying to be too sweet and soft about it or being too perky or being too, you know, energetic about it, they'll just tune out, they've had it. I am not their first rodeo, this is not the first person they've met, this is not the first time they've been messaged this.

Interviewer: It's probably been going on for years by their family doctor, it's the same spiel for them.

P7: Exactly. So, if I put things in a bit more of a concrete sort of way, I tend to get better results. Is it perfect, no. does it work for everybody, no but it does tend to terribly scare the compliance into them a little bit just so we have a – like I just need feet. If you have feet, we're good. If you get rid of your feet, we're in really big trouble and I don't think they actually believe that it's going to happen. I don't think they actually believe – because it's like watching a pot of water boil, right, like this, these changes happen so slowly over time that they're not even noticing. They don't notice when the hair stops growing on their legs and they don't notice when they're toenails start blanching and they don't really notice because it happens so slowly. They don't notice that their feet aren't as sensitive as they used to be. You know, they just happen so slowly that their norm just keeps sliding along with it and they kind of need to be – like no, I need to wake up now, like this is bad and sometimes it works and sometimes it works really well but I've got men wearing ugly shoes and they're doing it, you know. So, yeah, with the other chronic conditions, such as rheumatoid arthritis, you don't have to convince them of anything. They're in so much pain in that they'll take whatever drug you give them, right and that's all very medication based. So, they'll dance in the middle of a field if it's going to make their pain less. So, the compliance with painful conditions is I find – there's no, you don't have to motivate them, they'll try anything.

Interviewer: And from my experience with patients with type 2 diabetes is that they go one of two ways when they are first diagnosed. It's like a huge wake up call for them. They start exercising, they change their die, they're managing their blood sugars, all fine, it's great and then you get the ones -

Author
Alluded to the fact that it might be because she sees them too late. Physios see poorly controlled T2D, which would make treatment and behaviour change more difficult. The ones that are managing well don't have a reason to seek physiotherapy services.

Author
Because she feels like they haven't gotten the message up until this point.

Author
Stressing the importance of foot care.

Author
T2D is brushed aside, and patients don't always take it seriously. Maybe it's because of the attitude that they can take medication and that's supposed to take care of it.

Author
By the time they've gotten to physio, they have received most, or all of this education and they haven't been able to adopt healthier lifestyles – more difficult to change

Author
How this participant communicates with patients with T2D specifically and she has found that this works for her.

Author
Again, patient's attitudes and beliefs about the seriousness of T2D.

Author
Interesting comparison.

Appendix K: Ethics Approval for Study 3

Western Research

Date: 24 September 2018

To: Dr. Denise Connelly

Project ID: 112495

Study Title: Exploring how a mobile health application affects the transition from a supervised education and exercise program to independent exercise in adults diagnosed with type 2 diabetes.

Application Type: HSREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 02/Oct/2018

Date Approval Issued: 24/Sep/2018 11:26

REB Approval Expiry Date: 24/Sep/2019

Dear Dr. Denise Connelly

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Background Questionnaire	Paper Survey	13/Sep/2018	2
BREQ2_GFALD Study 1	Paper Survey	12/Sep/2018	2
Consent Form	Written	20/Sep/2018	4

	Consent/Assent		
Diabetes Empowerment Scale_GFALD Study 1	Paper Survey	12/Sep/2018	2
End of Study Letter	End of Study Letter	12/Sep/2018	2
Flyer	Recruitment Materials	20/Sep/2018	4
Functional Assessment Protocol	Other Data Collection Instruments	12/Sep/2018	2
International Physical Activity Questionnaire Short Form	Paper Survey	12/Sep/2018	2
Interview Guide	Interview Guide	12/Sep/2018	2
Janssen_WesternEthics_Aug2018	Letter Document	21/Aug/2018	1
PARmedX	Paper Survey	12/Sep/2018	2
PARQ and You	Paper Survey	12/Sep/2018	2
Research Proposal_GFALD Study_Sarah Janssen	Protocol	14/Sep/2018	2
Telephone Script	Telephone Script	20/Sep/2018	3
Verbal Recruitment Script	Recruitment Materials	20/Sep/2018	3
Website Ad	Recruitment Materials	20/Sep/2018	4

No deviations from, or changes to, the protocol or WREM application should be initiated without prior written approval of an appropriate amendment from Western HSREB , except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

REB members involved in the research project do not participate in the review, discussion or decision.

The Western University HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.

Appendix L: Letter of Information and Consent for Study 3

Study Title: Exploring how a mobile health application effects the transition from a supervised education and exercise program to independent exercise in people diagnosed with type 2 diabetes.

Principal Investigator
Dr. Denise Connelly, PT, PhD
Elborn College, Western University

Student Researcher
Sarah Janssen, MSc
Elborn College, Western University

Funder Information
The Canadian Centre for Activity and Aging (CCAA) has provided facility and equipment use for the functional assessments and the "Get Fit for Active Living with Diabetes" (GFLA-D) program in-kind.

I am a PhD student at Western University in the Department of Health and Rehabilitation Sciences. We are planning to conduct a research study in collaboration with the Canadian Centre for Activity and Aging in London, Ontario that we invite you to take part in. This form has important information about the reason for doing this study, what we will ask you to do if you decide to be in this study and the way we would like to use information about you if you choose to be in this study.

Being invited for this study
Up to 30 participants will be enrolled in this study (3 GFAL-D programs with 10 participants each). You are asked to participate in this research study, as an adult who has been diagnosed with type 2 diabetes, to help explore how the mobile health application, MyFitnessPal®, effects the transition from a supervised education and exercise program to independent exercise in adults diagnosed with type 2 diabetes. The goal is to improve community programs that aim to promote exercise and healthy living for the treatment of type 2 diabetes.

What will I do if I choose to be in this research study?
We will ask you to complete the screening protocol, consisting of a medical questionnaire (PARQ and You, PARmedX), background questionnaire and the International Physical Activity Questionnaire to provide information on current physical activity levels. Eligible participants will be asked to complete a physical function assessment, which will consist of the six-minute walk test, timed up and go, the sit to stand test, arm curls, the back scratch and the sit and reach before and after completing the program. Body mass index, waist circumference, blood glucose and blood pressure will also be measured before and after the program. Participants will also complete the Behavioural Regulation in Exercise Questionnaire (BREQ-2) and the Diabetes

Empowerment Scale (DES), two questionnaires that provide information on motivation and self-efficacy, or confidence in participating in exercise, before and after the program.

Participants will be asked to participate in the 8-week "Get Fit for Active Living with Diabetes" (GFAL-D) program consisting of 2 exercise sessions and 1 education session per week. The exercise sessions will be 60 minutes each and consist of a 5-minute warm-up, 20-25 minutes of cardiorespiratory endurance, a 5-minute cool-down, 15-20 minutes of muscular strength and endurance, 5-minutes of balance training and 5-minutes of flexibility. We will be using the track, dumbbells, resistance bands, exercise balls and exercise mats. The education sessions will be 60 minutes each and participants will learn about how to perform safe and effective exercise, the benefits of exercise, healthy eating and disease prevention. Participants will be asked to download the free MyFitnessPal app in class and the facilitator will instruct participants on how to use MyFitnessPal, including how to input nutrition intake, scanning bar codes and how to input physical activity during the education sessions. Participants will be given time to ask questions and practice using MyFitnessPal.

You will be asked to participate in 1 in person interview at a public location suitable to the participant 1-month after completing the program. You will be asked to complete 2 phone interviews 6-months and 12-months after completing the program to share your experience with exercise and how you are using MyFitnessPal after completing the education and exercise program. You will also be asked to complete 2 short surveys (BREQ-2 and DES) after the 6-month and 12-month interviews.

Study time: Participation in the 8-week GFAL-D program (approx. 3 hours per week) and participation in 3 1-hour interviews (1 in person at a public location suitable to the participant and 2 phone interviews).

Study location: Participation in the 8-week GFAL-D program will take place at the Canadian Centre for Activity and Aging (CCAA).

I would like to audio-record the interviews to make sure that I accurately remember all the information you provide. If you prefer not to be audio-recorded, I will take notes instead. I may quote your responses in presentations or published work resulting from this study. A participant number will be assigned to you to protect your identity.

What other choices are there?
If you would like to enroll in the GFAL-D program but do not want to participate in this research study, you may register through the CCAA online at https://www.uwo.ca/ccaa/active/classes/inhouse.html for a fee.

Can participation in this study end early?
Participants are required to attend at least 80% of the exercise sessions (12 of 16 sessions) and at least 80% of the education sessions (6 of 8 sessions) during the GFAL-D program. If you do not attend at least 80% of these sessions, you will be withdrawn from the study by the investigators and will not be allowed to complete the GFAL-D program.

In the event of a medical emergency (i.e. cardiovascular event, hypoglycemia, injury that impairs ability to exercise, development of uncontrolled hypertension), participants will be withdrawn from the study by the investigator and will not be allowed to complete the GFAL-D program. If a participant's blood pressure is above 144/94, they will not be able to participate in the exercise session that day They may continue with the GFAL-D program if their blood pressure is below 144/94. However, participants that do not attend at least 12 exercise sessions and 6 education sessions will be withdrawn from the study by the investigators and will not be allowed to complete the GFAL-D program.

What are the possible risks?
Potential risks for participating in this study include injury and risk of falls during the physical function assessment including the six-minute walk test, timed up and go, sit to stand, arm curls, back scratch and the sit and reach tests. There are potential risks including cardiovascular events, hypoglycemia and risk of falling during the exercise sessions of the program. The student researcher is trained as a Senior Fitness instructor and GFAL-D facilitator to provide safe and effective exercise. The student researcher is trained in first aid and is CPR level C certified and there are first aid kits and an AED in the gym. In the event of an exercise-related injury, the emergency protocol by the CCAA will be implemented. In the event of a medical emergency, the participants emergency contact and family doctor will be notified.

If you are harmed as a direct result of taking part in this study, all necessary medical treatment will be made available to you at no cost.

You do not waive any legal rights by signing the consent form.

What are the possible benefits of me or for others?
Participants may or may not benefit from this study. You may experience health benefits from participating in an exercise and education program for people with type 2 diabetes. The study results may be used to help others with the improvement of community-based exercise programs.

Confidentiality
We will be collecting personal health information during the screening protocol. We will be collecting name, sex/gender, age, diagnosis of type 2 diabetes, fasting glucose/glycated hemoglobin, diabetic medication use, indication of other health problems, family doctor's name, marital status and education level. Audio recordings will also be collected. A study ID will be assigned to you and all data collection materials (questionnaires, functional assessments, interviews) will contain the study ID and not the participant's name.

Paper copies of surveys and functional assessments and memory sticks will be stored in a locked cabinet in a locked office in Elborn College at Western University. Paper copies and memory sticks will be stored and permanently destroyed as per Western University's policy. Audio recordings will not contain personal health information. Electronic data

(age and sex/gender for data analysis) will be stored on an institutional server, will be password protected and other security and back-up measures will be in place. A master list linking study ID and participant's name will be stored separately from data materials in the office of the Principal Investigator. The master list and electronic data will be stored and permanently destroyed as per Western University's policy. The student researcher (Sarah Janssen), Principal Investigator (Dr. Denise Connelly) and the Applied Research Coordinator at the CCAA (Shannon Belfry) will have access to the paper copies of surveys and functional assessments. Only the student researcher and Principal Investigator will have access to the audio recordings and electronic data prior to de-identification.

Results of this study may be used in publications and presentations. Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used.

Financial Information
Participation in this study will involve travel costs to the Canadian Centre for Activity and Aging for 8-weeks. You will not be paid for participating in this study. The GFAL-D program will be free if you choose to participate in this research study.

What are my rights as a research participant?
Participation in this study is voluntary. You may decide to be in this study, or to be in the study now and then change your mind. If you do not want to answer a question during the interview, we can skip to the next question. We can also take a break, continue at a later date or stop altogether. You may withdraw from this study at any time and you will not be penalized in any way. If you decide to withdraw during the interview, the researcher will ask you if the information already collected can be used.
Conflicts of Interest
There are no conflicts of interest to declare related to this study.

Who can I contact if I have questions or concerns about this research study?

If you have any questions about your rights as a participant, you can contact the following office at Western University:

Western Research Ethics Board
Western University

Consent
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. The Principal Investigator for this study is Dr. Denise Connelly. I agree to participate in the research study, "Exploring how a mobile health application effects the transition from a supervised education and

exercise program to independent exercise in adults diagnosed with type 2 diabetes", described above and will receive a copy of this consent form.

I would like to have my interviews audio-recorded ☐
I would not like to have my interviews audio-recorded ☐

_____
Participant's Name (printed)

_____ _____
Participant's Signature Date

My signature means that I have explained the study to the participant named above. I have answered all questions.

_____
Name of person obtaining consent (printed)

_____ _____
Person obtaining consent's Signature Date

Appendix M: International Physical Activity Questionnaire (IPAQ)

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(August 2002)

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ

The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ

Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation

Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ

International collaboration on IPAQ is on-going and an ***International Physical Activity Prevalence Study*** is in progress. For further information see the IPAQ website.

More Information

More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L.

(2000). *Assessment of Physical Activity: An International Perspective*. Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ hours per day _____ minutes per day

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ hours per day _____ minutes per day

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ days per week

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ hours per day _____ minutes per day

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ hours per day _____ minutes per day

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

Appendix N: Background Questionnaire for Study 3

Participant Number: _____

The purpose of this questionnaire is to learn more about the participants in this research study. The information you provide will be kept confidential and will only be used for program evaluation and eligibility purposes. Simply place a check (✓) in the space provided or write a brief response. You may choose not to answer any question. Results will be summarized across groups; no one will ever be identified. Please ask if you are unclear about any of the questions.

PART A

1. How did you hear about the GFAL-D program?
   _____
   _____
   _____

2. How will you be traveling to the CCAA?
   _____
   _____
   _____

3. What are your personal reasons for participating in this research study?
   _____
   _____
   _____
   _____

4. Have you previously participated in an exercise class before volunteering for this research study?
   _____ no

   _____ yes, a class at this center What type of class?_____
   When? Year_____ How long? _____

   _____ yes, at a different center What type of class?_____
   When? Year_____ How long? _____

5. How sure are you that you would be able to do the exercises in the GFAL-D program without becoming overly fatigued, tired, or short of breath? (Circle number)

0	1	2	3
Very sure (no problem)	Pretty sure (may be too much)	Not very sure	Don't know (never tried before)

6. Do you have any reservations or concerns about participating in this research study?
   _____ no
   _____ I may not have the skills to keep up
   _____ I may not be able to schedule time to attend all classes
   _____ I may have transportation problems
   _____ other concerns
   (specify):_____
   _

PART B

Medical history

1. Are you a current, regular smoker? _____ no _____ yes
2. Have you been diagnosed with type 2 diabetes by a health profession? _____ no _____ yes
3. What was your last glycated hemoglobin (HbA1c) or fasting glucose level?
   _____
4. How long have you been diagnosed with type 2 diabetes?
   _____
5. Are you taking insulin for your type 2 diabetes? _____ no _____ yes
6. Are you taking one or more anti-diabetic medications? _____ no _____ yes
   If yes, what are you taking?
   _____
   _____
   _____
   _____
7. Have you been diagnosed by a health professional as having any of the following? (Check all that apply)

   Heart trouble _____
   Severe high blood pressure _____
   Neuropathy _____
   Nephropathy _____

Cerebrovascular disease	_____
High cholesterol	_____
Osteoporosis	_____
Arthritis	_____
Chronic asthma, emphysema, Or bronchitis	_____
Back problems	_____
Foot problems	_____
Trouble hearing	_____
Trouble seeing	_____

Other health problems (please list):
_____
_____
_____
_____
_____

8. Are you currently on any other prescribed medications? ___ no (Go to next question)
   ___ yes
   If yes, what is the medication(s) for (for example, heart or arthritis)?
   _____
   _____
   _____

9. Who is your family doctor?
   _____

PART C

Personal information

1. Are you ___ male or ___ female
2. What is your age? _____
3. What is your phone number? _____
4. What is your email? _____
5. Who is your emergency contact? Name _____Number _____
6. What is your current marital status?

Single ___
Married ___
Separated/divorced ___
Widowed ___
Other ___

7. What is the highest level of education you have completed?

Some secondary/high school ___
High school diploma ___
Some post-secondary ___
College/university degree ___
Graduate/professional degree ___

8. Are you currently retired?

Yes, fully retired ___
Yes, semi-retired ___
No ___

9. Do you own a smartphone, tablet or iPAD? ___ no ___ yes

Thank you very much for providing us with this information. The information you and other participants in this research study will greatly assist us in evaluating, developing and implementing community exercise programs that meet the needs and expectations for future participants.

Appendix O: Interview Guide for Study 3

The following questions will be asked during the initial in-person interview:

1. What was your experience of being diagnosed with type 2 diabetes (T2D)? How did you manage your T2D prior to the GFAL-D program?
2. What self-management tools do you use to manage your T2D after completing the GFAL-D program? How do you know these strategies are working?
3. How often have you exercised in the last week? How many days per week? How many minutes per session?
4. How do you consider exercise in the management of your T2D after completing the GFAL-D program?
5. Can you recall a time you first notices that exercising was working for your T2D management? How did you know?
6. If you use MyFitnessPal®, tell me how and when you use it?
7. How does MyFitnessPal® influence you to exercise?
8. How can you tell that the MyFitnessPal® is working? What do you find useful about MyFitnessPal®? What do you find least useful?
9. Is there anything else you would like to add?

The following questions will be asked during the six- and 12-month in-person interview:

1. What self-management tools do you used to manage your T2D presently? How do you know these strategies are working?
2. How often have you exercised in the last week? How many days per week? How many minutes per session?
3. If you are continuing to exercise, how have you maintained exercise adherence?
4. Tell me about a day when you didn't exercise, what factors influenced you to not exercise? How did you use MyFitnessPal® on a day like this? What factors influenced you to exercise the next time?
5. If you continue to use MyFitnessPal®, tell me how and when you use it?
6. Tell me about a time when you didn't use MyFitnessPal®, how did it change your daily life?
7. How can you tell that MyFitnessPal® is still working?
8. Is there anything else you would like to add?

The following questions will be asked as probing questions:

1. Did your family doctor/nurse practitioner recommend exercise/physical activity? Did they refer you to any community services? If so, what were they?
2. How do your family/friends influence your T2D management?
3. What types of activities do you do?
4. What types of barriers to exercise do you face?
5. What motivates you to exercise?
6. How confident are you in using MyFitnessPal®? Have you experienced technical issues? If yes, how have you dealt with these issues?

7. If you are not using MyFitnessPal®, how are you managing your T2D? Are you continuing to exercise?
8. Tell me about a time when you were ill/unmotivated, how did that affect your T2D management?

Appendix P: Copyright Release Form for Study 3

AGREEMENT IN RELATION TO COPYRIGHT IN AN ARTICLE FOR A TAYLOR & FRANCIS/ROUTLEDGE JOURNAL

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Article (the "Article") entitled: Assessing physical function after completing a supervised education and exercise program in adults with type 2 diabetes and exploring exercise motivation at one-year follow up: A case series study

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POST-SECONDARY EDUCATION:

Western University
London, Ontario, Canada
2017-2022 PhD Physical Therapy

Western University
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2019-2021 MPT Physical Therapy

University of Waterloo
Kitchener, Ontario, Canada
2015-2017 MSc Pharmacy

University of Guelph
Guelph, Ontario, Canada
2011-2015 HBSc Human Kinetics (Minor in Nutritional and Nutraceutical Science)

PEER-REVIEWED PUBLICATIONS

Janssen, S.M., Connelly, D.M., & Gillis, H. (2022). Physiotherapists perspectives on type 2 diabetes as a primary condition for referral to physiotherapy services. Submitted to *Physiotherapy Canada* [February 2022].

Janssen, S.M., Connelly, D.M., & Gillis, H. (2022). Educators' perspectives on the teaching, learning, and practice of type 2 diabetes content in physiotherapy programs across Canada. *Physiotherapy Canada*, e20210045. Doi: 10.3138/ptc-2021-0045.

Hoang, M., Jentz, E., **Janssen, S.M.**, Nasteska, D, Cuozzo, F, Hodson, D.J., Tupling, A.R., Fong, G-H., & Joseph, J.W. (2022). Isoform-specific roles of prolyl hydroxylases in the regulation of pancreatic β-cell function. *Endocrinology, 163*(1), bqab226.

Janssen, S.M., Connelly, D.M., Shields, C., & Landry, M. (2021). Assessing physical function after completing a supervised education and exercise program in adults with type 2 diabetes and exploring exercise motivation at one-year follow up: A case series study. *Physiotherapy Theory and Practice*, 1-14. Doi: 10.1080/09593985.2022.2097968.

Janssen, S.M., & Connelly, D.M. (2021). The effects of exercise interventions on physical function tests and glycemic control in adults with type 2 diabetes: A systematic review. *Journal of Bodywork and Movement Therapies, 28,* 283-293.

Modarresi, S., **Janssen, S.M.**, Seens, H., & Modarresi, G. (2021). Building effective therapeutic relationships in pelvic floor rehab: a commentary. *RehabINK, 1*(11). Available from: http://rehabinkmag.com.

Abdelmagid, S.A., MacKinnon, J.L., **Janssen, S.M.**, & Ma, D.W.L. (2016). Role of n-3 polyunsaturated fatty acids and exercise in breast cancer prevention: identifying common targets. *Nutrition and Metabolic Insights, 9*, 71-84.

PEER-REVIEWED CONFERENCE PUBLICATIONS

Hoang, M, **Janssen, S.M.**, & Joseph, J.W. (2019). 2175-P: Isoform-specific roles of prolyl hydroxylase domain proteins in regulating beta-cell function. *Diabetes, 68*(Supplemental 1). Available from https://diabetesjournals.org/diabetes/article/68/Supplement_1/2175-P/61375.

WORKING MANUSCRIPTS

Connelly, D.M., Doralp, S., **Janssen, S.M.,** (2022). Utility of virtual placements for clinical education of Canadian physical therapy students: A scoping review of implementation, effectiveness, and the achievement of entry-to-practice competencies.

CONFERENCE PRESENTATIONS

Janssen, S.M., Connelly, D.M., Gillis, H. (2021). Type 2 diabetes content in academic curriculum of physical therapy programs across Canada. *CPA Congress 2021*. Virtual, May 13-16, 2021. Poster Presentation.

Janssen, S.M., & Connelly, D.M. (2019). Exploring how a mobile health application effects the transition to independent exercise in adults diagnosed with type 2 diabetes. *6th Canadian Obesity Summit*. Ottawa, Ontario, April 23-26, 2019. Poster Presentation.

Janssen, S.M., Connelly, D.M., Melling, C.W.J., & Landry, M. (2018). A systematic review of exercise effects on physical function and body composition for adults diagnosed with type 2 diabetes: clinical implications for health care providers. *London Health Research Day*. London, Ontario, May 10, 2018. Poster Presentation.

Janssen, S.M., & Connelly, D.M. (2018). The use of a mobile health application in the transition from supervised exercise to independent exercise in people with type 2 diabetes. *Health and Rehabilitation Sciences Graduate Research Conference 2018*. London, Ontario, February 1, 2018. Oral Presentation.

Janssen, S.M., & Joseph, J.W. (2017). The role of prolyl 4-hydroxylase in pancreatic beta cell insulin secretion. *Pharmacy Research Day*. Kitchener, Ontario, April 26, 2017. Poster Presentation.

INVITED LECTURES

Janssen, S.M. (2021). Phenomenology: Guest Lecture, Graduate Qualitative Research Methods in Health and Rehabilitation Sciences 9602 *Western University*, October 12th, 2021. 90-minute oral presentation.

Janssen, S.M. (2018). Mixed methods research: Guest Lecture, Graduate Qualitative Research Methods in Health and Rehabilitation Sciences 9602 *Western University*, December 4th, 2018. 90-minute oral presentation.

Janssen, S.M. (2018). Grounded theory: Guest Lecture, Graduate Qualitative Research Methods in Health and Rehabilitation Sciences 9602 *Western University*, October 2nd, 2018. 90-minute oral presentation.

Janssen, S.M. (2016). Respiratory physiology: Guest Lecture, Systems Approach to the Study of the Human Body II 110 *University of Waterloo*, May 12th, 2016. 120-minute oral presentation.

RESEARCH ASSISTANTSHIPS

May 2022-August 2022. Part-time Research Associate, scoping review of virtual physiotherapy clinical placements, *Western University*.

May 2015-August 2015. Part-time Research Associate, studying anaplerosis in pancreatic beta cell insulin secretion in cell and rodent models, *University of Waterloo School of Pharmacy*.

TEACHING ASSISTANTSHIPS

Qualitative Research Methods in Health and Rehabilitation Sciences, Western University, September 2021-December 2021.

Qualitative Research Methods in Health and Rehabilitation Sciences, Western University, September 2018-December 2018.

Fieldwork Preparation at the School of Occupational Therapy, Western University, September 2017-April 2018.
Systems Approach to the Study of the Human Body I, University of Waterloo School of Pharmacy, January 2017-April 2017.

Entrepreneurship in Pharmacy, University of Waterloo School of Pharmacy, September 2016-December 2016.

Systems Approach to the Study of the Human Body II, University of Waterloo School of Pharmacy, May 2016-August 2016.

Systems Approach to the Study of the Human Body I, University of Waterloo School of Pharmacy, January 2016-April 2016.

SCHOLARSHIPS

University of Waterloo Graduate Scholarship, $1500 annually, 2015-2017

University of Guelph Entrance Scholarship, $2000, 2011

CERTIFICATIONS

Western Certificate in University Teaching and Learning, Western University, February 2019

PEER-REVIEW CONTRIBUTIONS

2020-01-27 *Journal of Bodywork and Movement Therapies*