Using tele-health to enhance leisure time physical activity and motivation in adults with spinal cord injury: A pilot randomized control trial

By

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Abstract

Fewer than 15% of adults with spinal cord injury (SCI) meet the SCI physical activity guidelines. In adults with SCI, novel interventions to promote physical activity, such as those based in self-determination theory, and those that use online video-based modalities, have yet to be tested. The purpose of this pilot randomized controlled trial was to evaluate a tele-health, self-determination theory-based intervention aimed to enhance satisfaction of the basic psychological needs, motivation, and physical activity in adults with SCI. As part of a larger study, 14 participants were recruited and randomized to either the control or intervention group, 13 of which participated in this study. The intervention group received one, one-hour counselling session per week, for a total of eight weeks. The counselling sessions focused on fostering the basic psychological needs and autonomous motivation, teaching behaviour change techniques, and self-regulatory strategies, and used motivational interviewing. Both groups responded to a questionnaire at baseline, mid-intervention, and post-intervention. Hierarchical multiple regressions and effect sizes were used to examine to what extent the intervention predicted the outcome, when controlling for covariates and baseline levels. Results showed that compared to the control group, intervention participants had moderate to large increases in autonomous motivation, small increases in perceived satisfaction of the basic psychological needs, and small to large increases in LTPA. This randomized control trial has helped establish the feasibility of conducting SDT and tele-health based LTPA counselling interventions for adults with SCI. This pilot randomized control trial will help inform the basis of future studies to promote LTPA in adults with SCI.

Résumé

Moins de 15% des adultes ayant une lésion médullaire participent à la quantité hebdomadaire d'activité physique suggérée. Peu d'interventions visant à augmenter l'activité physique dans ce groupe sont fondées sur la théorie de l'autodétermination et utilisent des moyens innovatrice tel que la télésanté livrée par logiciel vidéo via internet. Cet essai randomisé contrôlé pilot a pour but d'augmenter la satisfaction des besoins psychologiques fondamentaux, la motivation, et de promouvoir l'activité physique chez cette population. Faisant partie d'une étude plus vaste, 14 participants ont été recrutés et randomisés à un groupe contrôle ou d'intervention, où 13 ont participé à cette étude. Le groupe d'intervention a reçu une session d'une heure par semaine pendant huit semaines. Les sessions ont utilisé l'entretien motivationnel et ont porté sur l'enseignement des techniques de changement de comportement et des stratégies d'autorégulation, en favorisant les besoins psychologiques et la motivation. Les deux groupes ont répondu à des questionnaires à trois moments différents. Des régressions hiérarchiques et des tailles d'effet ont été utilisées pour examiner dans quelle mesure l'intervention prévoyait le résultat après avoir contrôlé l'effet des covariables et des niveaux de base. Les résultats ont révélé qu'en comparaison avec le groupe de contrôle, le groupe d'intervention avait des augmentations modérées à grandes de la motivation autonome, une faible augmentation de la satisfaction des besoins psychologiques fondamentaux et une faible à grandes augmentations de l'activité physique. Les résultats de cette étude ont fourni une aperçue initiale de l'impact d'une intervention basée sur la théorie de l'autodétermination et qui utilise une nouvelle méthode (télé-santé) pour promouvoir l'activité physique chez les adultes ayant une lésion médullaire. Cet essai contrôlé randomisé aidera à informer des études futures afin de promouvoir l'activité physique chez les adultes ayant une lésion médullaire.

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Preface and Contributions of Authors

K. Chemtob is the primary author with roles in subject recruitment, intervention design and implementation as the physical activity counsellor, data analysis and interpretation, and thesis preparation.

Dr. S.N. Sweet, Assistant Professor, Department of Kinesiology and Physical Education, McGill University, the candidate's supervisor was actively involved in every step and decision made regarding the research study and the completion of this thesis. In addition, he created the research protocol with help from the co-authors, and was granted funding for this research study from the Craig H. Neilson Foundation [#364137; Enhancing Quality of Life Through Exercise: A Tele-Rehabilitation Approach (#NCT02833935 with ClinicalTrials.gov)].

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Dr. K. Arbour-Nicitopoulos, Assistant Professor, Faculty of Kinesiology and Physical Education, University of Toronto, was a member of the candidate's supervisory committee and a co-author and contributed to the design of the research protocol as a co-author for the research grant that was awarded to this study.

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List of Common Terms and Abbreviations

SCI= Spinal cord injury; damage to the spinal cord that results in permanent or temporary changes such as loss of muscle function, sensation, or autonomic function below the level of injury.

LTPA= Leisure time physical activity; a subset of physical activity or any movement of the body that is produced by skeletal muscles and that results in energy expenditure. LTPA refers to any recreational physical activity that one choses to do in their free time.

HAPA= Health action process approach; a psychological theory designed to describe, predict and explain health behaviour change.

SDT= Self-determination theory; a macro theory concerning people's inherent growth tendencies and innate psychological needs based on the social environment. It is concerned of human motivation, specifically, that the motivation behind one’s choices may be with or without external influence and interference.

MVPA= Moderate to vigorous leisure time physical activity; An intensity of leisure time physical activity that is perceived as moderately or very difficult. Moderate activity would accelerate the heart rate (e.g. free wheeling). Vigorous activity would accelerate the heart rate rapidly and requires a lot of effort (e.g. wheelchair aerobics).

MI= Motivational interviewing; a client-centered counselling approach with the goal to help the participant explore their ambivalence and provoke behaviour change.

RCT= Randomized control trial; A study design that randomly assigns participants into an experimental (receives the intervention) or a control group (does not receive the intervention) as a way of determining whether a cause and effect relationship exists between the intervention and the outcome.

Chapter 1: Introduction

Background

An estimated 86,000 people live with spinal cord injury (SCI) in Canada (Noonan et al., 2012). Adults with SCI are living longer and thus experiencing an increased risk of chronic conditions and declines in health (Jacobs & Nash, 2004). To help promote health, research has linked leisure time physical activity (LTPA) to numerous physiological and psychological benefits for adults with SCI (Hicks et al., 2011b; Tomasone, Wesch, Martin Ginis, & Noreau, 2013). As such, evidence-based, SCI specific LTPA guidelines were created to aid in the prescription and promotion of LTPA (Martin Ginis et al., 2011). Using these guidelines, a recent study found as little as 12% of a sample of adults with SCI in Quebec, Canada (N=73) reported meeting the recommended minutes of LTPA per week (Rocchi et al., 2017). The small percentage of adults with SCI meeting the current LTPA guidelines stresses a need for behavioural interventions that promote LTPA in this population (Nery, Driver, & Vanderbom, 2013).

To date, only nine studies have implemented behaviour change interventions to promote LTPA for adults with SCI (Arbour-Nicitopoulos, Martin Ginis, & Latimer, 2009; Arbour-Nicitopoulos, Tomasone, Latimer-Cheung, & Martin Ginis, 2014; Brawley, Arbour-Nicitopoulos, & Martin Ginis, 2013; Latimer, Martin Ginis, & Arbour-Nicitopoulos, 2006; Latimer-Cheung et al., 2013; Warms, Belza, Whitney, Mitchell, & Stiens, 2004; Zemper et al., 2003). Some interventions were associated with positive increases in LTPA (Brawley et al., 2013; Warms et al., 2004), however, others lacked significant results (Arbour-Nicitopoulos et al., 2014; Latimer-Cheung et al., 2013; Zemper et al., 2003) highlighting a lack of consistency across the literature.

Two of these interventions (Latimer et al., 2006; Arbour-Nicitopoulos et al., 2009) were the foundation of a telephone-based LTPA counselling service for adults with SCI, named Get in Motion (Arbour-Nicitopoulos et al., 2014). The service used self-regulatory strategies and motivational interviewing (MI); a client-centered counselling approach with the goal to help the participant explore their ambivalence and provoke behaviour change (Rollnick, Miller, Butler, & Aloia, 2009). The percentage of Get in Motion clients (N=65) who were physically active increased, although not significantly, from baseline to four months, and again at six months. More recently, a randomized control trial (RCT) found that a behavioral intervention that used a client-centered counselling approach for adults with SCI significantly improved LTPA (Nooijen et al., 2016), however, no motivational variables were assessed. This highlights a gap in the literature where a RCT is needed to assess the relationship between behavioural interventions, motivational variables, and LTPA in adults with SCI. Nonetheless, previous research has demonstrated that teaching self-regulatory strategies in combination with a client-centered counselling approach may be a promising strategy to maintain or promote LTPA in adults with SCI (Arbour-Nicitopoulos et al., 2014).

Although some behavioural intervention studies have used a client-centered approach (Latimer-Cheung et al., 2013; Nooijen et al., 2016) these studies have either been atheoretical, or grounded in the health action process approach (HAPA). While MI is not based in a specific theory, due to the similarities between MI and self-determination theory (SDT), it has been suggested that SDT should inform the practice of MI and thus guide the creation of its interventions (Miller & Rollnick, 2012).

SDT is a motivational theory based on the assumption that every human being has a tendency towards growth and well-being (Ryan & Deci, 2000). Based on SDT, personal growth

is achieved through 1) satisfying three main psychological needs of autonomy (i.e., volition in one's actions), competence (i.e., belief in one's actions) and relatedness (i.e., sense of belongingness) and 2) the development of autonomous motivation (i.e., engaging in activities that are perceived as valuable and enjoyable), while reducing controlled motivation (i.e., engaging in activities due to external control and pressure). The key to achieving these factors is through the social context**.** SDT-based interventions have shown promise to create this social environment, and promote LTPA behaviour change in a number of populations (Fortier, Duda, Guerin, & Teixeira, 2012), and recent data shows that autonomous motivation predicts LTPA among adults with SCI (Rocchi et al., 2017). However, a gap in the literature exists where an SDT-based intervention has not yet been tested among adults with SCI. To deliver such SDT-based interventions, it has been proposed that, innovative delivery methods such as tele-health may be feasible (Buman et al., 2011).

Tele-health is defined as the delivery of health education or health services through various tele-communication mediums such as the internet, websites or video conferencing (Phillips, Vesmarovich, Hauber, Wiggers, & Egner, 2001). Tele-health modalities including the telephone have been used to promote LTPA for adults with SCI. While many telephone-based interventions have successfully increased LTPA in adults with SCI (Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006; Warms et al., 2004), others lacked significant results (Arbour-Nicitopoulos et al., 2014, Latimer-Cheung et al., 2013). This lack of consistent improvements in LTPA behaviour across these tele-phone based interventions, in combination with high drop out rates (Tomasone, Arbour-Nicitopoulos, Latimer-Cheung, Martin Ginis, 2016) may suggest that an alternative tele-health delivery method that includes face-to-face interactions may be more beneficial for promoting health behaviours (Nery et al., 2013). In fact, some clients who dropped

out of the Get in Motion service also indicated preference for face-to-face interactions (Tomasone et al., 2016). Unfortunately, barriers such as transportation and accessibility often impede in-person participation for adults with SCI, emphasizing the importance of new strategies that allow at-home participation (Kosma, Cardinal, & McCubbin, 2005). One way to overcome these barriers is through the use of tele-health video-based interventions. Video-based interventions for health-related topics such as quality of life and pressure ulcers have shown success among adults with SCI (Phillips et al., 2001; Hill, Cronkite, Ota, Yao, & Kiratli, 2009; Martinez et al., 2017). However, to date, no such intervention for LTPA promotion has been conducted for this population, and none have been grounded in SDT.

Purpose and Hypotheses

The study is a pilot RCT implementing an eight week, video-based LTPA counselling intervention for adults with SCI. The intervention was based in SDT, and used behaviour change techniques and strategies from MI to motivate and counsel participants on their LTPA behaviour. The overall aim of the innovative eight-week tele-health intervention was to improve SDT variables and increase LTPA in adults with SCI. Specifically, this aim translated into distinct primary and secondary objectives. First, the proposed pilot RCT aimed to determine if the intervention group, compared to the control group, had a greater increase in perceived satisfaction of the basic psychological needs and autonomous motivation, and decrease in controlled motivation. As a secondary outcome, the proposed intervention aimed to determine if the intervention group reported greater increases in LTPA than the control group. Based on previous findings in the literature, it was hypothesized that for the primary outcomes, this SDT grounded tele-health intervention will have moderate effects on perceived basic psychological needs satisfaction (Fortier et al., 2012) and in autonomous, and controlled motivation (Fortier et

al., 2012) favoring the intervention over the control group. For the secondary purpose, we hypothesized moderate effects for LTPA (Arbour-Nicitopoulos et al., 2014) for the intervention group compared to the control group.

Chapter 2: Literature Review

Spinal Cord Injury

Currently, an estimated 86,000 people live with SCI in Canada (Noonan et al., 2012), and the number is projected to grow to 121,000 by 2030. A SCI is described as any injury to the spinal cord that results in either temporary or permanent change in the spinal cord's normal function. Individuals who acquire a SCI are often classified in two broad categories: paraplegia or tetraplegia. Paraplegia is defined as impairments or loss of motor and/or sensory function of the trunk, legs and/or pelvic organs, where injuries to the spinal cord are below the cervical segments (American Spinal Injury Association & American Paralysis Association, 1996). Tetraplegia involves impairments or loss of motor and/or sensory function of all four limbs, trunk and/or pelvic organs due to an injury in the cervical segments of the spinal cord (American Spinal Injury Association & American Paralysis Association, 1996). The American Spinal Injury Association has created a classification system where the extent of the injury can be graded on an impairment scale and classified on varying degrees between complete and incomplete. A Canadian-wide comprehensive community survey of adults with SCI (N=1,549) found these adults were mostly male (67%), paraplegic (58%), and had an incomplete injury (67%; Noreau, Noonan, Cobb, Leblond, & Dumont, 2014). Participants in the survey had a mean age of 50 years, an average number of years since injury equal to approximately 18 years, and a mean age at injury recorded at 31 years old. The survey also found motor vehicle accidents to be the main cause of SCI in Canada, with falls and SCIs caused by violence trending upwards (Noreau et al., 2014).

Without accounting for the projected increase in incidence of SCI in Canada, the current estimated direct (e.g., health care, medications, equipment) and indirect (e.g., morbidity,

premature mortality) economic cost for newly injured Canadians is an alarming $2.7 billion per year (Kruger, 2011). Adults with SCI are living longer and thus experiencing increases in the risk of chronic conditions and declines in overall quality of life (Jacobs & Nash, 2004). As a result, compared to the general population, adults with SCI are at a significant increased odds of heart disease and stroke (Cragg, Noonan, Krassioukov, & Borisoff, 2013), and report higher average levels of stress and depression (Post & Van Leeuwen, 2012). In addition, declines in physical fitness can exacerbate the impact of injury in adults with SCI (Jacobs &Nash, 2004).

These declines in physical fitness may directly contribute to the increased risk of many physical inactivity-related secondary health complications such as, cardiovascular disease, type II diabetes, osteoporosis, and obesity (Nash, 2005). In addition, reduced fitness among adults with SCI has been found to be associated with negative effects on independence, community participation, and quality of life in general (Martin Ginis et al., 2011). With the alarming decline in overall health and quality of life that accompanies a SCI, there is a need for strategies that can lessen the negative effects of injury and promote health in this population. Physical activity is a modifiable risk factor that can act as a strategy to effectively improve health, fitness and overall quality of life within the SCI population (Martin Ginis et al., 2011).

Physical activity can be defined as any movement of the body that is produced by skeletal muscles and that results in energy expenditure. Exercise is a subset of physical activity that is structured, planned, and repetitive (Caspersen, Powell, & Christenson, 1985). An alternative subset of physical activity is LTPA. LTPA refers to any recreational physical activity that one choses to do in their free time. This can include sports, walking/wheeling or exercising at a gym (Martin Ginis, Latimer, et al., 2010). In adults with SCI, greater LTPA, but not necessarily activities of daily living, has been associated with better health. LTPA is therefore recommended

as a central component of health interventions for adults with SCI (Martin Ginis, Latimer, et al., 2010).

Benefits of LTPA for Adults with SCI

While adults with SCI often report a decline in physical activity and physical fitness, LTPA participation is a modifiable risk factor that has been shown to improve various aspects of health. In this population, LTPA has been associated with increases in physiological benefits such as improvements in muscle strength and endurance, aerobic capacity, and a decline in the risk of chronic conditions (Buchholz et al., 2009; Hicks et al., 2011b; Jacobs, Nash, & Rusinowski, 2001). LTPA has also been shown to allow for numerous psychological benefits such as decreases in stress and depression, and improvements in overall quality of life for adults with SCI (Hicks et al., 2011b; Martin Ginis, Jetha, Mack, & Hetz, 2010; Sweet, Martin Ginis, & Tomasone, 2013; Tomasone et al., 2013).

Physiological benefits of LTPA. Increases in LTPA engagement has been associated with many physiological benefits such as decreases in the risk of chronic conditions, increases in aerobic capacity, and increases in muscle strength and endurance (Jacobs et al., 2001). Increases in muscle strength and endurance can help attenuate some of the musculoskeletal decline associated with SCI (Jacobs and Nash, 2004). Strength training in adults with SCI has been shown to produce significant changes in muscle strength. A recent literature review found arm ergometry training programs of six and eight weeks in duration resulted in significant improvements in maximal power output regardless of training intensity (Hicks et al., 2011b). Circuit programs have also emerged as effective resistance training programs to increase muscle strength. In one study, circuit resistance training increased muscle strength in as little as five weeks (Hicks et al., 2011). In the review, they found mixed exercise programs, including

strength, aerobic and mobility training, successfully increased peak power output, number of repetitions and weight lifted (Hicks et al., 2011b). Twelve weeks of circuit weight training was also found to increase strength, anaerobic power and upper extremity endurance in men with paraplegia (Jacobs et al., 2001).

While increases in muscle fitness have been shown to be successful in offsetting certain effects of physical deconditioning, the decline in cardiovascular endurance that is observed in adults with SCI must also be addressed (Jacobs and Nash, 2004). Aerobic training for adults with SCI has resulted in substantial improvements in cardiovascular fitness. A review by Jacobs and Nash (2004) found activities such as arm cranking, wheelchair propulsion, swimming, adapted sports and even circuit resistance training were effective at increasing peak VO_2 in adults with SCI. Similarly, six weeks of either interval training or arm ergometry was found to effectively improve peak VO_2 (Le Foll-de Moro, Tordi, Lonsdorfer, & Lonsdorfer, 2005; Sutbeyaz, Koseoglu, & Gokkaya, 2005).

In addition to declines in fitness, adults with SCI commonly experience an accelerated risk of disease, making it particularly important to target improvements in disease-related risk factors (Jacobs and Nash, 2004). The benefits of physical activity extend beyond cardiovascular and musculoskeletal health to other outcomes related to chronic conditions. For example, higher physical activity levels among adults with SCI was associated with lower risk factors for cardiovascular disease, type II diabetes, lower body mass index, percentage of fat mass, insulin resistance, and C-reactive protein, and a higher percentage of fat free mass (Buchholz et al., 2009). Additionally, physically active adults with paraplegia, but not tetraplegia, reported lower systolic blood pressure and a smaller waist circumference. Increases in LTPA participation for adults with SCI has been shown to produce numerous physiological benefits including,

improvements in muscle strength and endurance, aerobic capacity and a decrease in many disease-related risk factors.

Psychological benefits of LTPA. While the physiological benefits associated with increased LTPA participation are considerable, many psychological benefits have also been shown to accompany this behavior for adults with SCI. The benefits of LTPA include decreases in anxiety, stress, depression and pain (Martin Ginis & Hicks, 2007). In addition, adults with SCI who engage in regular LTPA reported better overall health, wellbeing, and quality of life (Martin Ginis, Jetha, et al., 2010). More specifically, LTPA engagement was positively related to quality of life in the social, physical and psychosocial domains among adults with SCI (Tomasone et al., 2013).

Few studies to date have looked at the mechanisms by which LTPA relates to improvements in quality of life. Research has determined that LTPA may improve quality of life in adults with SCI through changes in depression, and functional independence (Sweet et al., 2013). Among the 21 studies analyzed in the meta-analysis by Martin Ginis, Jetha et al. (2010), LTPA was found to significantly improve numerous variables related to subjective wellbeing such as fatigue, anger, anxiety, stress and depressive symptoms. Similarly, Hicks and colleagues (2003) found adults in the exercise group of a RCT who reported significant increases in fitness were accompanied with declines in stress and depression after training and in comparison to a control group. In addition to improvements in their level of perceived health and overall quality of life, the exercise group also reported higher scores for satisfaction with physical function.

The increase in physical function has been confirmed in the literature as regular physical activity was also shown to increase energy to perform activities of daily living. These activities included self-care, preparing meals, household chores and social interactions (Tasiemski,

Kennedy, Gardner, & Taylor, 2005). Improvements in the amount of overall strength and endurance that occurs with increases in LTPA would allow for many functional benefits for adults with SCI, including the ability to wheel longer, improve ease by which they can transfer in and out of their chair and improve overall mobility (Hicks et al., 2011a). Greater functional independence, and lower levels of depression are associated with greater quality of life when adults with SCI participate in LTPA (Sweet et al., 2013).

Alternatively, increases in fitness and quality of life was associated with decreases in the participant's level of pain (Hicks et al., 2003). The relationship between pain management and quality of life was confirmed as pain reduction was identified as a potential underlying mechanism to improve life satisfaction and depressive symptoms (Martin Ginis et al., 2003). One study found six months of resistance training using exercise bands and stretching was effective in decreasing the intensity of pain in the shoulder girdle in wheelchair users (Curtis et al., 1999). Similarly, a 2006 study found significantly less shoulder pain after an 8-week exercise intervention focused on the rotator cuff muscles in adults with SCI (Nawoczenski, Ritter-Soronen, Wilson, Howe, & Ludewig, 2006). Less pain, decreases in stress, anxiety and depression, in addition to increases in functional independence and overall quality of life expand on the psychological benefits that are afforded when adults with SCI engage in LTPA.

Current LTPA Levels in Adults with SCI

Regular LTPA accrues a number of physiological and psychological benefits for adults with SCI. Despite the widespread benefits of LTPA, a large physical activity epidemiological study in Canada (N=695) found 50% of adults with SCI participate in 0 minutes of LTPA (Martin Ginis, Latimer, et al., 2010). The concerning trend of physical inactivity among adults with SCI is not one that is unique to Canada. A German study (N=277) found similarly low rates

of physical activity participation, with 49% of their sample reporting no involvement in LTPA (Anneken, Hanssen-Doose, Hirschfeld, Scheuer, & Thietje, 2010). A recent study (N=73) confirmed the previous results as the authors found as many as 44% of adults with SCI in Quebec, Canada reported participating in 0 minutes of LTPA per week (Rocchi et al., 2017). Unfortunately, close to one half of the Canadian SCI population thus does not afford the numerous benefits of a physically active lifestyle.

The high rate of physical inactivity among adults with SCI highlights the importance of promoting an active lifestyle to improve health, fitness and quality of life (Martin Ginis et al., 2011). To effectively promote LTPA, it is essential to be informed on the types, amounts and intensities of activity that afford the associated benefits. Evidence-based, SCI specific LTPA guidelines were thus created to aid in the prescription and promotion of LTPA in this population. The SCI-specific physical activity guidelines recommend (a) at least 20 min of moderate to vigorous intensity aerobic activity two times per week and strength training exercises two times per week, involving three sets of 8–10 repetitions of each exercise for each major muscle group to enhance cardiorespiratory fitness and muscle strength, and (b) at least 30 minutes of moderate to vigorous intensity aerobic activity three times per week for cardiometabolic health (Martin Ginis et al., 2017).

The effects of following the SCI specific physical activity guidelines were evaluated using a 16-week, parallel-group RCT (N=23; Pelletier, de Zepetnek, MacDonald, & Hicks, 2015). Participants were randomized to either the intervention or active control condition. The intervention group participated in supervised training sessions that were designed to meet the SCI specific physical activity guidelines, whereas the control group was asked to maintain their current levels of physical activity. When assessing physical fitness related outcomes, they found

that adhering to the physical activity recommendations for 16 weeks was effective at significantly increasing peak aerobic capacity, aerobic endurance and muscle strength from baseline and in comparison to a control group (Pelletier et al., 2015). Additional outcomes related to cardiovascular disease risk factors including blood biomarkers, body composition and arterial structure and function were analyzed in a secondary analysis. They found that although no changes in blood biomarkers of cardiovascular disease were observed, following the physical activity guidelines for 16 weeks was effective in maintaining body composition and improving carotid artery distensibility (de Zepetnek, Pelletier, Hicks, & MacDonald, 2015). The RCT concluded that the current guidelines were an effective means to increase physical fitness and maintain body composition for adults with SCI.

With the availability of the physical activity guidelines for adults with SCI, it is possible to look more closely at the extent to which adults with SCI meet these guidelines and engage in LTPA. In a cross-sectional study, Rocchi et al. (2017) examined the degree to which a sample of Canadians living with SCI (N=73) met the SCI-specific physical activity guidelines. They found only 36% of the sample met the guidelines for aerobic activity, 19% was engaging the recommended amount of resistance training, and 12% met the current SCI physical activity recommendations for both aerobic and resistance activity (Rocchi et al., 2017).

A comparable 2015 study in Switzerland (N=485) examined the levels of LTPA engagement for adults with SCI based on the World Health Organization's (WHO; 2010) recommendation of at least 2.5 hours of moderate intensity physical activity per week. In this study, 48.9% of adults with SCI were meeting WHO physical activity recommendations, and 18.6% of their sample were completely inactive (Rauch, Hinrichs, Oberhauser, & Cieza, 2016). Promoting physical activity is necessary to improve the health, fitness and quality of life of

adults with SCI. Unfortunately, the majority of adults with SCI in Canada do not afford the numerous health benefits that accompany regular LTPA participation. Alarmingly low rates of LTPA engagement emphasizes the importance that should be accorded to the development of strategies to promote physical activity for adults with SCI.

Interventions to Promote LTPA for Adults with SCI

The small percentage of adults with SCI meeting the current LTPA recommendations stresses a need for interventions that promote LTPA in this population (Nery et al., 2013). Behavioral approaches can be effective for LTPA promotion because they focus on teaching behavioral management and regulatory strategies through individual or group behavioral counselling sessions. Such approaches have been shown to effectively promote LTPA behavior change in the home, family, school and work environments (Nery et al., 2013). Furthermore, this intervention strategy is likely to be effective across various diverse groups, including adults with physical disabilities, as the content of the behavior change intervention can be adapted to the appropriate population (Kahn et al., 2002). Behaviour change interventions teaching regulatory strategies such as finding a role model, recalling past experience, goal setting and planning have been identified as factors which may increase LTPA participation in adults with SCI (Kerstin, Gabriele, & Richard, 2006).

Unfortunately, a systematic framework classifying the current status of research on LTPA and SCI identified a gap in the literature where very few studies have examined the effects of individual level behaviour change interventions on LTPA engagement (Nery et al., 2013). To date, only nine studies have implemented behaviour change interventions to promote LTPA for adults with SCI (Arbour-Nicitopoulos et al., 2009; Arbour-Nicitopoulos, et al., 2014; Brawley, et al., 2013; Latimer et al., 2006; Latimer-Cheung et al., 2013; Warms et al., 2004; Zemper et al.,

2003). These interventions were primarily based on teaching self-regulatory strategies such as goal setting (establishing measurable goals and time frames), action planning (establishing where, when, and for how long you will do LTPA), coping planning (establishing a plan to overcome barriers) and implementation intentions (establishing a cue linked to a goal or intention). The most recent interventions were focused on enhancing self-efficacy, intentions and planning as theoretical determinants of LTPA. All nine interventions involved either telephone interviews or in-person counselling sessions to increase LTPA engagement, however, one study examined LTPA as one factor in overall holistic SCI wellness program.

A holistic wellness program targeting LTPA, nutrition, lifestyle management and prevention of secondary conditions was created for adults with SCI (Zemper et al., 2003). The RCT (N=43) used six 4-hour wellness group workshops over a three-month period, one individual counselling session and two follow up phone calls. A follow up assessment was also conducted four months later. While a module was taught on LTPA, it is unclear from the article what specific tools and strategies were provided. Paired *t* tests showed significant improvements in the intervention group for increases in self-reported LTPA (from a LTPA subscale in a health promotion questionnaire) from baseline to four months post-intervention, with no change for the control group. Unfortunately, an alternative LTPA questionnaire specific for adults with disabilities showed no significant changes from baseline or between groups. In addition, no significant differences from baseline or within groups were observed for measures of physical fitness and biometric data (Zemper et al., 2003). Although no effect sizes were reported, the authors suggested small sample size might have played a role in this lack of significance. Details as to what strategies were taught during the LTPA module of the intervention could provide additional insight into the absence of meaningful findings in this research. Furthermore, the

intervention was not guided in behaviour change theory. Using health behaviour change theory as the basis of future LTPA interventions may allow for more meaningful results (Nery et al., 2013)

Despite the limitation in the Zemper et al intervention (2003), subsequent interventions have grounded their interventions in theory and have described the strategies employed. For one, Warms and colleagues (2004) delivered a four-week intervention grounded in the transtheoretical model (Prochaska & Velicer, 1997) that provided stage-matched educational materials, a home visit from a nurse and four follow up phone calls (Warms et al., 2004). The 90-minute home visit included MI techniques, goal setting, and action planning, whereas the follow up phone calls were used to renegotiate goals and for problem solving. MI is a client-centered counselling approach with the goal to help the participant explore their ambivalence and provoke behaviour change (Rollnick et al., 2009). A single group pre-post test of the program (N=12) was conducted, and LTPA was measured using actigraphy and record logs of self report. Six weeks post-intervention, results showed 60% of the participants increased their LTPA participation from baseline, but the changes were not statistically significant. Significant changes were observed post-intervention for exercise self-efficacy, muscle strength and perceived health after six weeks (Warms et al., 2004). As this study was lacking a control group, it is impossible to determine if the observed changes were uniquely the result of the intervention.

Similar to the intervention conducted by Warms et al. (2004), 13 adults with SCI who were already active completed a nine-week, group-based, pre-post intervention aimed to increase LTPA (Brawley et al., 2013). The intervention included seven weekly one-hour group sessions where participants learnt self-regulatory strategies such as planning and self-monitoring. In the last two weeks of the intervention, the participants planned their own LTPA programs and

engaged in one telephone-based counselling session (Brawley et al., 2013). The research was based on the HAPA model (Schwarzer & Luszczynska, 2008) as self-regulatory strategies are essential to behaviour engagement for actors in the volitional phase (Martin Ginis et al., 2013). Post-intervention, paired samples *t* tests found large, significant increases, with most individuals doubling in their weekly minutes of self-managed LTPA as compared to baseline measures. Similarly, the research found self-regulatory efficacy for planning and scheduling LTPA remained high post-intervention. This study suggests regulatory strategies tailored to actors with SCI may be effective at increasing LTPA (Brawley et al., 2013). Unfortunately, small sample size and a lack of control group limit the generalizability and implications of the research respectively. While the current literature highlights the need for RCTs to determine cause and effect, this study was important to establish the feasibility of teaching regulatory strategies and conducting group and telephone-based counselling to promote LTPA for adults with SCI.

A Canadian research group conducted RCTs and intervention studies to examine the effects of regulatory strategies on the promotion of LTPA for adults with SCI. Two RCTs used the telephone and as the primary intervention delivery method. The research conducted by this group explored the feasibility and efficacy of teaching regulatory strategies and conducting telephone-based interventions to promote LTPA for adults with SCI.

This research group first conducted a RCT (N=54) based on the theory of planned behaviour (Ajzen, 1985) to examine the use of regulatory strategies in the promotion of LTPA for adults with SCI. They applied an eight-week LTPA intervention including SCI-specific educational materials and two phone calls with an interventionist. Both groups were asked to engage in self-monitoring but only the intervention group was prompted to develop goals, action plans, implementation intentions and problem solving strategies. Both groups were then asked to

engage in 30 minutes of LTPA three times per week. After eight weeks, participants in the intervention group engaged in more minutes of daily LTPA than those in the control group (Latimer et al., 2006). While the results were non significant, barrier self-efficacy and perceived behavioural control had large effect sizes for the intervention group compared to the control group. The authors suggest that these trends may have reached significance in a larger sample (Latimer et al., 2006).

The effects of regulatory strategies were further examined in a subsequent RCT (N=44) where the relationship between action planning alone or in combination with coping planning was examined in terms of it's ability to increase LTPA participation in adults with SCI. Over 10 weeks, each participant received a pamphlet outlining the basics of LTPA and then participated in three telephone interviews where they were asked to make either an action plan or both an action and coping plan, depending on which condition they had been assigned to. The research was based on comparing regulatory strategies rather than testing a theory-based intervention. Results showed that supplementing action plans with coping plans and action plans alone both significantly increased LTPA participation (Arbour-Nicitopoulos et al., 2009). The research demonstrated that scheduling self-efficacy was the only significant mediator of the total effect of the intervention on LTPA after five weeks. The results from the research conducted by this group confirms the feasibility and efficacy of teaching regulatory strategies to promote LTPA through telephone-based counselling for adults with SCI (Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006).

The results of these two interventions were used to guide the development of a real-world telephone mediated LTPA counselling service for adults with SCI called Get in Motion. The effectiveness of Get in Motion was tested in community-dwelling adults with SCI. (Arbour-

Nicitopoulos et al., 2014). The service was based on the two aforementioned telephone-based RCTs, MI (Rollnick et al., 2009) and the HAPA model (Schwarzer & Luszczynska, 2008). This service expanded on, and lasted considerably longer than previous RCTs conducted by the research group. Get in Motion allowed for up to 14, 10-15 minute interactions with an experienced LTPA counsellor over 6 months. Sixty-five clients participated in the Get in Motion service, and were contacted weekly for the first two months, every two weeks for months two to four, and then monthly for months four to six. The counselling sessions were tailored to the client's specific motivational stages based on the HAPA model (Schwarzer & Luszczynska, 2008) and incorporated strategies such as action planning, goal setting, coping planning, and social support. The percentage of clients who were physically active increased from baseline versus four months, and again at six months, however, the results were not statistically significant. This lack of significance may be a result of almost one third of the Get in Motion clients being already active at baseline (Arbour-Nicitopoulos et al., 2014). Similarly, due to high scores on intentions at baseline, no significant change in intentions was observed. From this lack of change in intentions, it can be concluded that the Get in Motion service may have helped adults with SCI maintain their already high motivation to participate in LTPA. Nonetheless, Get in Motion demonstrates that telephone-based counselling may be a promising strategy to promote or maintain LTPA in adults with SCI (Arbour-Nicitopoulos et al., 2014).

For the second phase of Get in Motion, 46 participants received physical activity counselling over six months (Tomasone et al., 2016). As the research served to evaluate a service, participants self-selected their session frequency. Similarly, as the service is based in motivational interveiwing, intervention content varied for each participant. Although the study had a dropout rate of 45%, results found that similar to the first phase of Get In Motion, this

service sustained participants intentions to particpate in LTPA (Tomasone et al., 2016). Additonally, they found that increases in aerobic LTPA was positively related to intervention dose, content, and perceived reliability of the service, demonstrating the key implimentation variables for a LTPA counselling service for adults with SCI (Tomasone et al., 2016).

This research group conducted two more interventions based on the previous findings from the Latimer et al. (2006) and the Arbour-Nicitopoulos et al. (2009) studies. Whereas the 2009 study employed regulatory strategies and was not specifically grounded in psychological theory, these two separate interventions were partly grounded in MI (Rollnick et al., 2009), the HAPA model (Schwarzer & Luszczynska, 2008) and the self efficacy component of social cognitive theory (Bandura, 1977). The first intervention (N=7) used a single MI counselling session to target several sources of self-efficacy. The aim of the session was to improve confidence in the participant's ability to schedule, set goals, use implementation intentions, and overcome barriers, as well as strengthen their intentions to reach their goals and engage in LTPA (Latimer-Cheung et al., 2013). With this intervention, they demonstrated a single telephone-based, MI counselling session effectively increased intentions and confidence in goal setting ability for LTPA. Small to medium effect sizes were found for intentions to become active and for action planning, however the results did not reach significance. Furthermore, small non-significant decreases were observed in scheduling and barrier self efficacy post-intervention (Latimer-Cheung et al., 2013). The authors suggest small sample size and a need for a greater emphasis on action and coping planning, and on goal progression may have contributed to the lack of significance. Nonetheless, the results showed that as little as one MI counseling session may increase self efficacy to set LTPA goals and intentions to reach these goals in adults with SCI.

The second intervention (N=12) employed one home-based strength training session by both a peer and a personal trainer. Within this session, they used goal setting and action planning to create an individualized resistance band-based exercise program. The sessions also targeted the four sources of self-efficacy as described in social cognitive theory to enhance task self-efficacy to perform strength training activities. Strength training behaviour significantly increased four weeks post-session as compared to baseline (Latimer-Cheung et al., 2013). Additionally, this intervention included both motivational and volitional intervention components based on the HAPA model (Schwarzer & Luszczynska, 2008), which emphasizes the use of regulatory strategies to promote behaviour and improve LTPA participation. One home-based strength training session successfully improved several determinants of LTPA (task self-efficacy, barrier self-efficacy, action planning, and intentions) as per the HAPA model. This research group therefore demonstrated the feasibility to apply theory-based interventions to promote LTPA among adults with SCI.

A 2016 study from the Netherlands conducted an RCT (N=39) where a behavioural intervention was implemented in combination with a traditional hand cycle rehabilitation program (Nooijen et al., 2016). The intervention group participated in 13 MI sessions conducted in person or over the telephone over 5 months. Based on an objective measure of LTPA, results found that adults with SCI who received the intervention significantly increased their wheeled LTPA at six and 12 months post intervention compared to the control group (Nooijen et al., 2016). Unfortunately, this RCT was not grounded in theory, and did not examine motivational variables, leaving it unknown why the intervention had its impact.

The literature to date has demonstrated the efficacy and feasibility of teaching regulatory strategies to promote LTPA for adults with SCI. While several of the presented studies used MI

in an attempt to change the participant's behaviour, few RCTs have examined the motivational factors that may provide a better understanding as to how behavioural interventions work to promote LTPA. Nonetheless, research has shown that as little as one MI counseling session may increase self efficacy to set LTPA goals, intentions to reach these goals, and wheeled activity in adults with SCI.

When promoting health behaviours using MI, research has shown significant behaviour change can occur as a result of a single session, however, length and number of sessions is positively associated with greater changes (Martins & McNeil, 2009). In agreement with this association, the Get in Motion service used MI sessions and techniques throughout its six-month duration, however, a control group was not available for comparison. In addition, the RCT by Nooijen and colleagues used recurrent MI session in their intervention, however no motivational outcomes were examined. A gap in the literature therefore exists where RCTs are needed to establish the relationship between MI sessions, motivational outcomes, and LTPA in adults with SCI.

MI has been widely successful at promoting various health behaviours, however, there is no current theoretical framework that is used to understand it's processes (Markland, Ryan, Tobin, & Rollnick, 2005). The research that has examined the use of MI to promote LTPA for adults with SCI has been atheoretical (Nooijen et al., 2016), or based on the HAPA model (Latimer-Cheung et al., 2013; Tomasone et al., 2016). Unfortunately, interventions that are based on the HAPA model may not target the social environment essential to promoting motivation to engage in LTPA.

Although, MI interventions for adults with SCI have been based alongside the HAPA model, there appears to be research supporting that LTPA interventions for adults with physical

disabilities may benefit from providing individuals with a sense of control and autonomy over their behaviour change. Specifically, a meta-synthesis examined the qualitative research and theory surrounding LTPA interventions for adults with physical disabilities (Williams, Ma, & Martin Ginis, 2017). Ten articles were reviewed, and the authors gave several suggestions based on participants' experiences. Apart from highlighting the importance of regulatory strategies, the authors explained that participants need supportive relationships and care. Furthermore, they suggested that interventions should promote a sense of control over LTPA, which may help promote self-efficacy and engagement among participants (Williams et al., 2017). Interestingly, the suggestions derived from the meta-synthesis to individualize interventions, give support and care, promote self-efficacy, and foster autonomy, can be contextualized within SDT. Using SDT to guide the style of content and communication within interventions may help facilitate LTPA and MI interventions (Quested, Ntoumanis, Thøgersen-Ntoumani, Hagger, Hancox, 2017). For this reason, a motivational theory such as SDT (Deci & Ryan, 2002) may be a useful framework for MI interventions (Markland et al., 2005).

SDT and MI have many parallels that can be drawn between their principles. For example, both MI and SDT are based on the assumption that each individual has an innate tendency towards growth and well-being, and MI allows for the social environment that is needed to support this tendency. It has therefore been suggested that SDT should inform the practice of MI and thus guide the creation of future MI interventions (Miller & Rollnick, 2012).

Self-determination Theory

SDT is a meta-motivational theory based on the assumption that every human being has a tendency towards personal growth and well-being (Ryan & Deci, 2000). SDT includes six mini-theories: cognitive evaluation theory (CET), organismic integration theory (OIT), causality

orientations theory, basic needs theory, goal content theory and relationships motivation theory (Deci & Ryan, 2002; Deci & Ryan, 2014). To promote LTPA for adults with SCI, a theoretical focus will be placed on two mini-theories; CET and OIT. According to CET, personal growth is achieved through a social environment that is supportive of the three basic psychological needs of autonomy, competence and relatedness. Autonomy can be explained as volition in one's actions, such as an adult with SCI who has control and choices regarding the specific type of LTPA he/she would like to engage in. Competence is understood as having belief in one's actions. For example, an adult with SCI who is assured in their ability to perform LTPA would exhibit competence. Relatedness, the third basic psychological need can be defined as a sense of belongingness. An adult with SCI who feels accepted and understood would have their need for relatedness satisfied. In an LTPA context, a physical activity counsellor could provide a need supportive social environment by incorporating interpersonal (e.g. empathising and acting in a warm and caring way) and social (e.g. maximizing the participant's choices) strategies that facilitate satisfaction of the basic psychological needs. According to CET, satisfaction of the three basic psychological needs can support the development of intrinsic motivation.

As per OIT, types of motivation are placed on a continuum ranging from amotivation, to extrinsic motivation, and to intrinsic motivation (Ryan & Deci, 2000). As one begins to see more value in the behaviour, it becomes more internalized allowing the individual to move along the continuum. Amotivation is the least intrinsic, and represents a lack of motivation to perform a behaviour. For example, a person with SCI who has no desire to engage in LTPA would exemplify being amotivated.

Extrinsic motivation is characterized by four types of regulations: external, introjected, identified, and integrated. Each type of extrinsic motivation becomes more internalized and

moves closer to intrinsic motivation on the continuum. External regulation is understood as engaging in a behaviour because one gains a reward or satisfies an external demand. For example, adults with SCI who perform LTPA activities only to satisfy the demands of their family would be considered externally motivated. Introjected regulation is defined as engaging in a behaviour to avoid feelings of guilt or to attain feelings of pride. This type of motivational regulation can be seen in adults with SCI who engage in LTPA because they feel guilt when they are not physically active. Identified regulation is when one participates in a behaviour because he/she values its benefits and sees the activity as personally important. An adult with a SCI who is physically active because he/she identifies the importance of the physical and psychological benefits associated with this behaviour, would exemplify having an identified motivation. Lastly, integrated regulation is explained as engaging in a behaviour because it is incorporated into one's self. For example, integrated regulation could be observed in an adult with SCI who regularly plays wheelchair rugby because he/she sees themselves as a rugby athlete. An individual's internalization of motivation allows them to move along the motivational continuum towards more internalized behaviour and intrinsic motivation (Ryan & Deci, 2000).

Intrinsic motivation is defined as one engaging in an activity solely for internal reasons such as enjoyment and for pure satisfaction derived from the activity/behaviour (Ryan & Deci, 2000). For example, an adult with a SCI who plays wheelchair rugby because he/she inherently enjoys the activity would exhibit intrinsic motivation. Intrinsic motivation is the most internal type of motivation. On the motivational continuum, the types of regulation/motivation can be combined to create autonomous or controlled motivation. Autonomous motivation includes identified and integrated regulation, and intrinsic motivation while controlled motivation is composed of external and introjected regulation. (Deci & Ryan, 2002).

SDT has been used to explain factors in the social environment that enable autonomous motivation and well-being across diverse settings and domains (Deci & Ryan, 2002). Specific to the health context, constructs within this theoretical model have been shown to predict greater physical activity participation (Teixeira et al., 2012). As such, SDT-based interventions have been shown to be promising for promoting physical activity behaviour change (Fortier et al., 2012), and the theory has been used as the guiding framework for promoting physical activity in a number of populations (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). However, SDT has yet been tested among adults with SCI. Such evaluation will enable the generalization of SDT to a different population.

Self-determination Theory and LTPA. There has been a recent growth in the application of SDT to the study of LTPA (Teixeira et al., 2012). A 2012 systematic review examined 66 empirical studies on various constructs from SDT and their relationship with LTPA. The results showed a positive relationship exists between autonomous motivation and LTPA, with identified regulation predictive of short-term LTPA adoption and intrinsic motivation predictive of long-term LTPA adherence (Teixeira et al., 2012). While all types of studies and not only experimental research was reviewed, all forms of autonomous regulation, including integrated, identified, and intrinsic motivation were associated with LTPA participation. The results provide evidence for the value of SDT in understanding physical activity behaviour and in the development of physical activity interventions (Teixeira et al., 2012).

SDT has been shown to be valuable in understanding physical activity behaviour across a wide variety of samples including, adults with disabilities (Saebu, Sørensen, & Halvari, 2013). A SDT process model was tested during a three-week physical rehabilitation stay for 44 adults with

disabilities, 55% of which were wheelchair users. The participants engaged in a SDT-based program where they completed three to five hours of physical activity a day, six days a week for three weeks (Saebu et al., 2013). The staff at the rehabilitation center were trained in SDT to ensure they created an environment that supported autonomy, competence and relatedness. In a path model with residual change scores, satisfaction of the basic psychological needs at baseline predicted total increases in physical activity, mediated by residual change in autonomous motivation. The results supported the SDT process model for adults with disabilities, calling on a need for SDT based interventions to enhance autonomous motivation and physical activity among this population (Saebu et al., 2013).

A similar program based in SDT was later implemented as an intervention. A rehabilitation-based intervention was used to promote LTPA for adults with disabilities (N=214) over four weeks (Skatteboe et al., 2016). Participants were asked to complete questionnaires at eight time points, including four weeks and one year after completing their rehabilitation. Multiple linear regressions and multi-level models were performed to examine the trajectories of motivation, and LTPA over one year. Although improvements in motivation were not related to changes in LTPA and the improvements in autonomous motivation were not maintained post intervention, the intervention group reported a significant increase in autonomous motivation after four weeks (Skatteboe et al., 2016). This study suggests that barriers and situational factors may explain the lack of increase in LTPA in this disability population, and highlights the importance of increasing autonomous motivation throughout the rehabilitation stay. Although this study did not demonstrate the relationship between physical activity and autonomous motivation in their sample of adults with disability, this relationship has been suggested for adults with SCI specifically.

A recent study (N=73) found autonomous motivation to be a correlate of the likelihood of meeting the LTPA guidelines in adults with SCI (Rocchi et al., 2017). These findings suggest the importance of motivation in the promotion of LTPA. Unfortunately, no study to date has used a SDT-based intervention to promote LTPA for adults with SCI, highlighting a gap in the current literature.

SDT and LTPA promotion for healthy inactive adults. Physical activity interventions grounded in SDT have however been studied across a variety of groups including healthy inactive adults and specific populations who may experience mobility impairments. Two key studies have implemented and evaluated physical activity promotion interventions grounded in SDT among healthy inactive adults (Fortier et al., 2012). The Physical Activity Counselling trial and the Empower trial used in-person physical activity counselling based in SDT and MI techniques to promote LTPA. Both studies supplemented their interventions with follow up consultations using the telephone. The aim of both trials was to enhance autonomous motivation and physical activity participation (Fortier et al., 2007; Jolly et al., 2009).

The Physical Activity Counselling trial examined how autonomy supportive physical activity counselling can positively influence motivation and physical activity participation (Fortier et al., 2007). One hundred and twenty participants who were not meeting the physical activity guidelines were randomized to either a brief or intensive counselling condition. The brief counselling group received one 2-4-minute autonomy supportive counselling session with a health care provider. The intensive counselling group received the brief session with a health care provider followed by a three-month intensive autonomy supportive counselling intervention (Fortier et al., 2007). The intensive intervention consisted of three in-person sessions and three telephone sessions based on an integrated SDT-MI model (Markland et al., 2005). The results

showed a medium sized overall effect on quantity and quality of motivation, with significantly higher levels of autonomous motivation in the intervention group as compared to baseline and the control condition. Similarly, increases in motivation resulted in increases in physical activity from baseline to 13 weeks, and between groups at the end of the intervention (13 weeks; Fortier et al., 2007). The results from this study suggest SDT-MI trained counsellors can enhance motivation and promote physical activity participation for a healthy inactive population.

The effects of an SDT-based intervention for a healthy inactive population were later examined on an even larger scale with The Empower Trial (N=347). This study compared the effects of a physical activity program delivered by a health and fitness advisor trained in the principles of SDT and the standard advisors already working with the National Health Service in the United Kingdom (Jolly et al., 2009). Participants were randomized to either the control condition or experimental condition. The control group interacted with the standard advisor and participated in a one-hour initial consultation where they were given a personalized exercise program and offered supervised exercise sessions for the following three months (Jolly et al., 2009). Over the three-month period, they received three follow-up consultations either on the phone or in person. The intervention group followed a similar timeline, however they worked with a counsellor trained in the principles of SDT and their counselling sessions incorporated specific strategies grounded in SDT and MI.

At three and six months post-baseline, participants in the intervention and control groups had significantly higher levels of LTPA compared to baseline, however there was no significant difference observed between groups. No significant difference was found in perception of autonomy support provided by the counsellor when comparing the control and intervention conditions (Duda et al., 2014). Upon validation and rating of the consultation sessions, the

authors found that while overall need support was higher for the SDT trained counsellors, the amount of autonomy support provided to participants was not significantly different between the two groups (Rouse, Duda, Ntoumanis, Jolly, & Williams, 2014). These results from the counselling validation analysis are consistent with the results from the trial as there was no difference observed in perceived autonomy support between the intervention and control groups (Duda et al., 2014).

The authors suggest that logistical challenges may have compromised the SDT-based training of the counsellors, accounting for the lack of significant difference in autonomy support between the groups. For example, external licencing examinations and other work related demands may have compromised the SDT training of the physical activity counsellors (Duda et al., 2014). As such, the authors indicate that the challenges associated with the SDT trainings may have resulted in the SDT basis of the intervention being less rigorously implemented. To effectively satisfy the basic psychological needs, the physical activity counsellor must allow for a need supportive social environment. While this intervention was not entirely successful at creating a need supportive environment, a process model determined that, for all participants, a higher perceived need satisfaction was related directly to their intention to continue with physical activity after the three-month program (Duda et al., 2014). The results from the path analysis confirmed the importance of SDT in understanding physical activity behaviour in a healthy inactive population.

SDT and LTPA promotion for populations who may present mobility impairments. No study to date has examined the effects of a SDT-based LTPA intervention for adults with SCI. However, interventions have been conducted for specific populations that may experience

mobility impairments. Four specific interventions are discussed which includes obese women, patients with rheumatoid arthritis, and older adults.

The Promotion of Health and Exercise in Obesity Trial examined the effects of a one-year SDT and MI-based intervention on physical activity behaviour and weight loss in 239 obese women in Portugal (Silva et al., 2008). The intervention group received 30 group sessions lasting approximately 120 minutes each and were focused on increasing autonomous motivation and competence towards physical activity and weight control, whereas the control group only received counselling on general health education. The intervention was shown to successfully increase physical activity participation after one year and at a two-year follow up (Silva et al., 2008). Furthermore, the intervention group increased their perceived need support, autonomous motivation, competence and enjoyment of exercise as compared to the control group. The results established the feasibility of long term, group based counselling to promote physical activity in women with obesity (Silva et al., 2008).

The efficacy of SDT-based interventions in the promotion of physical activity in obese women was confirmed with an eight-week RCT (N=25; Hsu, Buckworth, Focht, & O'Connell, 2013). Obese women were randomized to either the SDT intervention group or to a supervised exercise training only control group. The intervention group received a one-hour group based behaviour change counselling session and 30 minutes of supervised exercise training per week (Hsu et al., 2013). The counselling strategies were based on teaching regulatory strategies and discussing types of physical activity in different settings. Both groups were asked to engage in 150 minutes of physical activity outside of the program, and data were collected at baseline, post intervention and four weeks post-intervention. Both groups showed a large effect size on changes in energy expenditure from baseline to post intervention. For the control group, the effect size for

energy expenditure declined four weeks post-intervention whereas the effect size for the intervention group increased from the end of the intervention to four weeks post-intervention. The intervention group saw moderate effect sizes on increasing intrinsic motivation, identified regulation and integrated regulation during the intervention. The intervention group also reported moderate-large effects on autonomy and competence satisfaction, and the effects became greater at follow-up. The positive results confirm the feasibility of a SDT-based intervention for sedentary overweight women (Hsu et al., 2013).

The effectiveness of SDT-based interventions has also been tested in other populations such as patients with rheumatoid arthritis. Seventy-eight patients with arthritis were randomized to either a five-week intervention or a control group (Knittle et al., 2015). The intervention aimed to increase autonomous motivation, self-efficacy and physical activity. The control group received a 20-minute patient education session, while the intervention group received the same education session, one MI session and two self-regulation coaching sessions. The intervention group then received three follow-up phone calls (Knittle et al., 2015). Significant post-intervention increases were observed for the intervention group in self efficacy and autonomous motivation. Similarly, post-intervention, more participants in the intervention group met current physical activity guidelines than the control group. The increases in self efficacy, autonomous motivation and LTPA participation were maintained at six months post-intervention, demonstrating the long term efficacy of SDT-based interventions on a unique population that often experiences mobility impairments (Knittle et al., 2015).

Another group that may experience mobility impairments are older adults (O'Hanlon & Twomey, 2009). A group-based peer mentoring intervention based in SDT and social cognitive theory (Bandura, 1986) was tested in a 16-week RCT (N=91). Older adults were randomized to

either a SDT-based peer mentorship intervention where they learned skills for physical activity initiation and maintenance (feedback, goal setting, social support, problem solving and relapse prevention), or a control group (Buman et al., 2011). The control group mimicked a standard community-based physical activity promotion program where the participants had two physical activity educational classes and access to an exercise facility. At 16 weeks, both groups reported significantly more self-reported physical activity participation compared to baseline, with no significant differences between the groups. However, at the 18-month follow-up, the intervention group reported significantly more self-reported minutes of physical activity then the control condition (Buman et al., 2011). Furthermore, the intervention group showed significantly higher scores in autonomous motivation relative to the control condition at 16 weeks and 18 months post-intervention. The results confirmed the intervention effectively increased autonomous motivation and encouraged long-term physical activity engagement for older adults (Buman et al., 2011).

The SDT-based LTPA literature presents implications to the future design of community-based physical activity interventions for healthy inactive adults, older adults, adults with obesity, rheumatoid arthritis or any population who presents with reduced mobility (Buman et al., 2011; Fortier et al., 2007; Hsu et al., 2013; Knittle et al., 2015; Silva et al., 2008). SDT-based LTPA interventions have been effective in promoting autonomous motivation and LTPA participation for adults with disabilities and in populations that may present with mobility impairments. However, the absence of studies testing SDT in the context of LTPA in adults with SCI highlights a significant gap in the literature.

The majority of the SDT-based intervention research that has been conducted to date has shown significant short- and long-term increases in physical activity participation. When

significance was not met for increases in physical activity, the results described an equal lack of significance in the implementation of the intervention and in the satisfaction of the basic psychological needs (Duda et al., 2014). As a result, future interventions should emphasize the importance of creating a need supportive environment for the successful implementation of SDT based interventions. Appropriate training has been suggested as one way to ensure the counsellor provides a social environment that is supportive of the basic psychological needs (Williams, Hendry, France, Lewis, & Wilkinson, 2007). Alternatively, innovative delivery methods have also been proposed to help promote a successful SDT based intervention. It has been suggested that different delivery channels for SDT-based programs, such as internet and telephone-based interventions, should be evaluated for feasibility (Buman et al., 2011). While the current literature has significant gaps, innovative delivery methods for physical activity interventions, such as tele-health, could be used to create a need supportive social environment.

Tele-health

The use of innovative delivery methods and technology in the health care domain is quickly advancing (Prince, Croghan, Sheridan Jr, & Weatherly, 2005). Tele-health is defined as the delivery of health education or health services through various tele-communication mediums (Phillips et al., 2001). With tele-health, participants can receive health-related information using various forms of technology such as the internet, websites or video conferencing. Furthermore, tele-health allows the participant to receive the information from any location, eliminating the need for transportation and making the service more globally accessible (Phillips et al., 2001). Tele-health allows health-care providers to reach a broader range of populations who otherwise would not engage in health behaviours including LTPA (Patrick & Canevello, 2011). Tele-health interventions with a number of different modalities have been conducted with various

populations such as adults with physical disabilities (Kosma et al., 2005), and more specifically adults with SCI (Dorstyn, Mathias, & Denson, 2013). Tele-health modalities have also been used to implement SDT-based interventions to promote LTPA with a healthy inactive population.

Tele-health and SDT-based LTPA interventions. Interventions to promote many health behaviours including LTPA have employed tele-health modalities as the primary delivery method (Webb, Joseph, Yardley, & Michie, 2010). A recent meta-analysis that examined the effects of web-based interventions on health behaviour change found interventions that were extensively based in theory tended to have larger effect sizes. While the meta-analysis found that many theories of health behaviour had been used to guide internet based interventions, no study had used SDT as a guiding framework (Webb et al., 2010).

Since the 2010 meta-analysis, one identified study has examined the effects of a web-based SDT and MI intervention to promote LTPA entitled I Move (Friederichs et al., 2014). The aim of the intervention was to increase and maintain LTPA among healthy inactive adults. The computer program was designed to incorporate SDT and MI skills and processes in four separate sessions (Friederichs et al., 2014). MI skills such as asking open ended questions, reflective listening, affirming and summarizing, as well as motivational processes such as engaging, focusing, evoking and planning were incorporated into the computer program. The first interactive session used a web-interface to begin a discussion on the participants' current LTPA level. Participants discussed how confident they are at becoming more active and how important it is for them to increase their LTPA, a technique derived from MI (Friederichs et al., 2014). In the first session, participants could also choose to make an action plan. The second and third sessions followed the same steps, with the option to adjust action plans and create coping plans. The fourth session gave the participant a chance to overview the topics previously covered.

Unfortunately, the authors included little information on how SDT was used to guide the intervention, apart form stating that MI strategies worked to support the basic psychological needs of the participants (Friederichs et al., 2014).

The efficacy of the I Move intervention was evaluated in a 3-month RCT (N= 3089). Participants were randomized to either the I Move group, the Active Plus group or a waiting list control group. The Active Plus group received the Active Plus web-based computer tailored LTPA intervention, a previously existing intervention based on several theories of health behaviour change including the theory of planned behaviour, the social cognitive theory and the transtheoretical model (Friederichs et al., 2014). From baseline to six months, both the I Move and Active Plus interventions were found to significantly improve autonomous motivation and identified regulation for LTPA as compared to the control group; however, no significant difference was found between the I Move and the Active Plus groups (Friederichs, Bolman, Oenema, Verboon, & Lechner, 2016). Both interventions significantly increased the number of weekly days with greater than 30 minutes of LTPA at three and six months post-intervention, however, the Active Plus condition yielded a greater effect (Friederichs, Oenema, Bolman, & Lechner, 2016). Conversely, the I Move intervention group was found to have a significant increase in weekly minutes of LTPA, while Active plus condition did not. It could not be concluded that the web-based intervention grounded in SDT was more effective at increasing LTPA engagement than the standard web-based intervention. Although the efficacy of the SDT-based intervention could not be confirmed, I Move participants perceived more basic psychological need support during the intervention sessions than the participants in the Active plus condition (Friederichs, Bolman, et al., 2016). This study confirmed that SDT-based interventions delivered using innovative tele-health methods can effectively create a need

supportive environment (Friederichs, Bolman, et al., 2016). Apart from creating a social environment that is supportive of the basic psychological needs, tele-health interventions include a number of additional benefits such as reduced cost and increased availability (Phillips et al., 2001). Innovative tele-health intervention modalities are specifically beneficial for populations who struggle with accessibility of intervention programs such as adults with physical disabilities (Kosma et al., 2005).

Tele-health research to promote LTPA for adults with physical disabilities. While tele-health interventions have a wide range of applicability, they may be especially important for adults with physical disabilities (Kosma et al., 2005). Transportation is often cited as a common barrier for this population, however, tele-health mediated LTPA counselling can effectively eliminate traveling as a barrier to LTPA participation (Vissers et al., 2008). Tele-health interventions allow adults with SCI to participate in LTPA counselling without requiring any traveling on the part of the user (Arbour-Nicitopoulos et al., 2014). While none have applied a SDT approach, tele-health interventions to promote LTPA among adults with physical disabilities have been conducted using a number of various modalities including interactive websites and the telephone.

A motivational website aimed to promote LTPA for adults with physical disabilities was tested using a randomized controlled trial (N=151). Participants included in the study had a wide range of disabilities, however adults with SCI represented approximately one third of the sample. The website was based on the transtheoretical model and used constructs such as social support, goal setting, self-monitoring and rewards to target LTPA participation for adults in the precontemplation, contemplation and preparation stages (Kosma et al., 2005). A moderate effect size for the amount of LTPA performed post-intervention and between groups was observed in

favour for the intervention condition, but the results did not reach significance. The lack of statistical significance is likely due to a large dropout rate of nearly 50% by the end of the four-week intervention (Kosma et al., 2005). The lack of adherence highlights a need for more interactive and engaging interventions to promote LTPA in adults with disabilities, and more specifically for adults with SCI.

Different tele-health modalities including the telephone have been used to promote LTPA for adults with SCI. As discussed in a previous section outlining the existing LTPA promotion literature for adults with SCI, telephone-based interventions among this population have been relatively common. Multiple studies have examined the effects of teaching regulatory strategies such as goal setting, coping planning, action planning, implementation intentions, and self-monitoring using telephone-based interviews (Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006; Warms et al., 2004). Research has also demonstrated the benefits of a single telephone-based MI LTPA counselling session (Latimer-Cheung et al., 2013), and a telephone-based LTPA counselling service for adults with SCI called Get in Motion (Arbour-Nicitopoulos et al., 2014).

More recently, a 2017 RCT (N=84) found that a six-month telephone based intervention, significantly improved life satisfaction and health self-management among adults with SCI (Houlihan, et al., 2017). Similarly, a recent eight-week RCT (N=24) evaluated the efficacy of a multi-modality web-based physiotherapy program for adults with SCI (Coulter et al., 2017). Twenty-four participants were randomized to either the control (N=8) or intervention group (N=16), where the intervention group received eight weeks of web-based physiotherapy. Although the within and between group differences were non-significant, the authors explained that the mean difference associated with standardized exercise tests for the intervention group represented a meaningful clinical difference which may be important in this population (Coulter

et al., 2017). Furthermore, qualitative interviews were conducted with each intervention participant, and supported the notion that the tele-health based intervention was perceived as beneficial and enjoyable. Their results provide evidence to support the use of web-based physiotherapy programs, however more research is needed to help motivate adults with SCI to continue to be active post intervention (Coulter et al., 2017). While the research confirms the feasibility of this modality for adults with SCI, results were mixed in terms of the efficacy of telephone-based programs to improve LTPA participation. While many telephone-based interventions have successfully increased LTPA in adults with SCI, the lack of consistent improvements in LTPA behaviour across the literature may suggest that an alternative method could be more effective.

A systematic review found that seven studies used tele-health modalities to counsel adults with SCI in mental health and well-being. While, the review found that multiple modalities such as the telephone and the internet were effective, only one study had used videoconferencing to deliver their intervention (Dorstyn, et al., 2013; Phillips et al., 2001). Although few studies have examined video-conferencing as a tele-health delivery method in adults with SCI, the efficacy of providing at-home care through video-conferencing has been established with older adults (Crotty et al., 2014). A recent study (N=78) used tablet computers to provide video-based tele-rehabilitation services for older adults. They found older adults who received rehabilitation through videoconferencing were satisfied with their services, met the majority of their rehabilitation goals and reported few technical problems. Furthermore, previous experience with the technology and age of the participants did not present as barriers to the delivery modality (Crotty et al., 2014). The results confirmed the feasibility of using videoconferencing in a population of older adults.

The established feasibility of such modalities in other populations combined with the need for increased accessibility and at home face-to-face counselling for adults with SCI highlights a gap in the literature and a demand for a tele-health video-based interventions to promote LTPA in this population. Video-based interventions for health-related topics such as quality of life and pressure ulcers have been studied among adults with SCI, however, to date, no such intervention for LTPA promotion has been conducted for this population.

Video-based tele-health interventions for adults with spinal cord injury. While the effects of video-based interventions to promote LTPA in adults with SCI have yet to be studied, the efficacy of a video-based tele-health intervention to improve quality of life in this population has been examined (Phillips et al., 2001). A RCT (N=111) was conducted to compare the effects of a nine-week video-based, telephone and standard intervention. Both the video and telephone groups participated in 30 to 40 minute sessions with a nurse where they discussed aspects of routine care such as nutrition, bowel and bladder function, skin care, and psychosocial issues. The only difference between the video and the telephone intervention was that the video consultations allowed for the participant and the nurse to see each other over a computer. The control group received only standard follow-up care (Phillips et al., 2001). While scores for health-related quality of life did not differ significantly between the three conditions after nine weeks, one year later, both intervention groups reported significantly higher scores as compared to the control condition. Both intervention conditions additionally reported half as many mean annual hospital visits than the control group, however, there was no significant differences observed between the two intervention delivery methods (Phillips et al., 2001). The lack of significant difference observed between the video and telephone based interventions could be a reflection on the technology that was available when study was conducted. The video-based

intervention used a speakerphone and camcorder attached to a small laptop to record video feeds, and then transmitted the video feed using standard telephone lines (Phillips et al., 2001). This delivery method seems somewhat primitive in comparison to the large growth in tele-health intervention technology that has been observed in recent years.

A more recent and technologically advanced study used a similar design to compare the effects of two tele-health modalities (telephone only and video-conferencing) and standard in-person assessment for diagnosis of skin integrity and pressure ulcers in adults with SCI (Hill, et al., 2009). Participants (N=42) were independently assessed by three modalities including video-conferencing using a patient telemedicine unit, a more advanced technology than the standard telephone lines used to promote quality of life in the 2001 study by Phillips and colleagues. Both telephone and video-conferencing approaches had no significant differences across several variables for diagnosis of a pressure ulcer in comparison to the in-person assessment (Hill et al., 2009). Moreover, the video-conferencing condition reported measures of pressure ulcer size that were closer to the in-person modality than the telephone condition. The results found that while both modalities were effective, video-conferencing was better overall than the telephone only condition in assessing pressure ulcers (Hill et al., 2009).

Similarly, a recent study examined the efficacy of video conferencing to provide health services to veterans with SCI in the United States (Martinez et al., 2017). They interviewed 40 health care professionals and found that while the patients appreciated the face-to-face contact they received from the tele-health service, health providers found it somewhat difficult to assess physical complaints through this modality (Martinez et al., 2017). While health services that require physical contact such as wound care have less definitive results, specialties that rely on

more verbal interactions, such as physical activity counselling, find tele-health most effective (Gilman & Stensland, 2013).

As technology advances, tele-health is growing in terms of its ability to provide effective services and interventions for adults with SCI. Modalities such as the internet and the telephone have worked to promote LTPA for adults with SCI, while eliminating transportation and accessibility as a barrier to participation (Arbour-Nicitopoulos et al., 2014; Kosma et al., 2005). With recent growths in technology, video-conferencing is gaining popularity for its ability to offer effective at home health-care services, and has even been shown to be more effective than other technologies such as websites or the telephone (DelliFraine & Dansky, 2008). A meta-analysis examining various tele-health modalities suggests that the real-time interaction between the participant and the health care provider that is achieved in video-conferencing strongly influences various clinical outcomes across numerous populations such as those with diabetes, heart disease and psychiatric conditions (DelliFraine & Dansky, 2008). Unfortunately, a significant gap in the literature exists where video-based tele-health technology has yet to be studied for the promotion of LTPA in adults with SCI.

Significance of the Study

This pilot RCT will extend the current literature and enhance our knowledge on motivation and LTPA promotion in adults with SCI. To date, despite its use in the general population (Friederichs et al., 2016; Teixeira et al., 2012), no study has used SDT to promote LTPA in adults with SCI, and no RCT has examined the motivational factors that may provide a better understanding as to how behavioural interventions can promote LTPA in this population. In addition, applying SDT to the physical activity context in adults with SCI, may help expand the generalizability of the theory. As the first study to use an SDT-based intervention to promote

LTPA in this population, this research addresses a gap in the literature. Similarly, in adults with SCI, no LTPA intervention has used a video-based tele-health modality and thus the results will help determine the feasibility of such novel interventions. This pilot study may help guide the creation of a larger RCT to promote LTPA participation for adults with SCI.

Chapter 3: Manuscript

Using tele-health to enhance leisure time physical activity and motivation in adults with spinal cord injury: A pilot randomized control trial

Keryn Chemtob BSc, Shane N. Sweet PhD

Introduction

An estimated 86,000 people live with SCI in Canada, and the number is projected to grow to 121,000 by 2030 (Noonan et al., 2012). While the prevalence of SCI is increasing, adults with SCI are also living longer. As a result, this population is at an increased risk of developing chronic conditions (Cragg et al., 2013), report declines in overall quality of life (Jacobs & Nash, 2004), and higher average levels of stress and depression compared to the general population (Post & Van Leeuwen, 2012).

Although adults with SCI are at an increased risk for declines in health and quality of life (Jacobs & Nash, 2004), leisure time physical activity (LTPA; i.e., recreational physical activity done in his/her free time) has been associated with widespread physiological and psychological benefits for adults with SCI (Hicks et al., 2011b; Jacobs, Nash, & Rusinowski, 2001; Tomasone et al., 2013). As such, LTPA may be one avenue for health promotion in this population. Evidence-based, SCI specific LTPA guidelines were thus created to aid in the prescription and promotion of LTPA in this population. The SCI-specific physical activity guidelines recommend (a) at least 20 minutes of moderate to vigorous intensity aerobic activity and strength training exercises two times per week for muscle strength benefits for cardiorespiratory fitness, and (b) at least 30 minutes of moderate to vigorous intensity aerobic activity three times per week for cardiometabolic health (Martin Ginis et al., 2017).

A recent study found as little as 12% of a sample of adults with SCI in Quebec, Canada (N=73) reported meeting the recommended minutes of LTPA per week (Rocchi et al., 2017). Similarly, a large physical activity epidemiological study in Canada (N=695) found that 50% of adults with SCI participated in 0 minutes of LTPA (Martin Ginis, Latimer, et al., 2010). These percentages clearly indicate a need for interventions to promote LTPA as a health behaviour in

this population. One method that may be feasible for this population are behavioral approaches, as they focus on teaching behavioral management and regulatory strategies through individual or group behavioral counselling sessions (Nery et al., 2013). Unfortunately, a systematic framework classifying the current status of research on LTPA and SCI identified a gap in the literature where very few studies have examined the effects of behaviour change interventions on LTPA engagement (Nery et al., 2013).

To date, only nine studies have implemented behaviour change interventions to promote LTPA for adults with SCI (Arbour-Nicitopoulos et al., 2009; Arbour-Nicitopoulos et al., 2014; Brawley et al., 2013; Latimer, et al., 2006; Latimer-Cheung et al., 2013; Warms, et al., 2004; Zemper et al., 2003; Nooijen et al., 2016). These interventions were conducted either in person or using the telephone, and were primarily based on teaching self-regulatory strategies such as goal setting, action planning, coping planning and implementation intentions. Additionally, several of these interventions were based in psychological theory including the health action process approach (HAPA) model, the theory of planned behaviour (Ajzen, 1985), and social cognitive theory (Bandura, 1986). Some interventions were associated with positive increases in LTPA (Warms et al., 2004; Brawley et al., 2013; Latimer et al., 2006; Arbour-Nicitopoulos et al., 2009; Nooijen et al., 2016), however, others lacked significant results (Arbour-Nicitopoulos et al., 2014, Latimer-Cheung et al., 2013; Zemper et al., 2003), highlighting a lack of consistency in the literature.

Two of these prior interventions (Latimer et al., 2006; Arbour-Nicitopoulos et al., 2009) were used to create a telephone-based LTPA counselling service for adults with SCI called Get In Motion (Arbour-Nicitopoulos et al., 2014). The service was also based on the HAPA model (Schwarzer & Luszczynska, 2008), and motivational interviewing (MI), a client-centered

counselling approach aimed to help the participant explore their ambivalence and provoke behaviour change (Rollnick et al., 2009). In Get in Motion, participants received up to 14, 10-15 minute interactions with an experienced LTPA counsellor over six months. In the first evaluation phase (N=65), the percentage of clients who were physically active increased from baseline (34.8%) to four months (47.8%) and again at six months (52.2%), however, the results were not statistically significant at either time point. Almost one third of the Get In Motion clients were active at baseline, which may explain the lack of significance (Arbour-Nicitopoulos et al., 2014). Therefore, this service may have helped individuals maintain their LTPA levels and high motivation, however it only consisted of a pre-post design, limiting any causal interpretations.

More recently, an RCT conducted in the Netherlands in adults with SCI implemented a behavioral intervention that used MI to promote LTPA (Nooijen et al., 2016). The intervention group significantly improved in total minutes of wheeled LTPA compared to the control group. However, no theoretical/motivational variables were assessed, leaving it unknown why the intervention had its impact. Previous SCI literature has examined some theoretical/motivational variables. For example, LTPA interventions in SCI that taught self-regulatory strategies through a MI approach found improvements in theoretical variables such as self-efficacy, perceived behavioural control, and intentions for LTPA (Latimer et al., 2006; Arbour-Nicitopoulos et al., 2014; Latimer-Cheung et al., 2013). As a result, combining self-regulatory and MI approaches may be a promising strategy to maintain or promote LTPA in adults with SCI (Arbour-Nicitopoulos et al., 2014).

Although MI is not grounded in a specific theory, it has been suggested that SDT should inform the practice of MI and thus guide the creation of MI interventions (Miller & Rollnick, 2012). SDT is a motivational theory based on the assumption that every human being has a

tendency towards growth and well-being (Ryan & Deci, 2000). Accordingly, personal growth is achieved through 1) satisfying three main psychological needs of autonomy (i.e., volition in one's actions), competence (i.e., belief in one's actions) and relatedness (i.e., sense of belongingness) and 2) developing autonomous motivation (i.e., engaging in an activity because individuals value it and enjoy it) while reducing controlled motivation (i.e., engaging in activities due to external control and pressure). The key to achieving these factors by creating a social environment that fosters the basic psychological needs and autonomous motivation.

Previous SDT-based interventions have shown promise to create this social environment, and to promote LTPA behaviour change (Fortier et al., 2012). These SDT-based interventions have generally shown significant short and long-term increases in LTPA participation and autonomous motivation among healthy inactive adults (Friederichs et al., 2016; Fortier et al., 2007; Duda et al., 2014) and populations who may present with mobility impairments (Silva et al., 2008; Knittle et al., 2015). To date, no SDT-based interventions have been tested among adults with SCI. However, a recent study (N=73) found that autonomous motivation predicted the likelihood of meeting the LTPA guidelines (Rocchi et al., 2017), showing its potential for this population.

Furthermore, SDT-based LTPA interventions in the literature have been delivered in majority using face-to-face counselling methods (Fortier et al., 2007; Silva et al., 2008). However, for adults with SCI, accessibility and transportation is often cited as a barrier to participation, and may limit access to face-to-face services (Vissers et al., 2008). Fortunately, advancements in technology may allow the necessary social environment to be created through novel modalities. Innovative delivery methods such as tele-health may be used to effectively eliminate accessibility barriers and deliver SDT-based interventions (Buman et al., 2011).

Tele-health is defined as the delivery of health education or health services through various tele-communication mediums (Phillips et al., 2001). With tele-health, participants can receive health-related information using various forms of technology such as the internet, websites or video conferencing. Furthermore, tele-health allows participants to receive information from any location, eliminating the need for transportation and making the service more accessible (Phillips et al., 2001). A meta-analysis examined the effects of web-based interventions on health behaviour change, and found that while many theories of health behaviour had been used to guide internet based interventions, no study had used SDT as a guiding framework (Webb et al., 2010).

Since the 2010 meta-analysis, one identified study has examined the effects of a web-based SDT and MI intervention (I Move) to promote LTPA among healthy adults (Friederichs et al., 2014). The computer program was designed to incorporate SDT and MI skills and processes. The efficacy of the intervention was evaluated in a 3-month RCT (N= 3089). From baseline to six months, the intervention (I Move) group was found to have a significant increase in weekly minutes of LTPA, compared to the control group. Additionally, the I Move group was found to have significantly improved autonomous motivation for LTPA as compared to the control group. This study confirmed that SDT-based interventions delivered using innovative tele-health methods can effectively create a need supportive environment to enhance autonomous motivation and LTPA (Friederichs, Bolman, et al., 2016).

Different tele-health modalities including the telephone have been used to promote LTPA for adults with SCI, however, results were mixed in terms of the efficacy of telephone-based programs to increase LTPA. While many telephone based interventions have successfully increased LTPA in adults with SCI (Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006;

Warms et al., 2004), others lacked significant results (Arbour-Nicitopoulos et al., 2014, Latimer-Cheung et al., 2013). Furthermore, in the second phase of Get in Motion, 21 out of 46 participants dropped out before completing the telephone-based physical activity counselling intervention (Tomasone et al., 2016). This lack of consistent significant improvements in LTPA behaviour across these interventions may suggest that an alternative method could be more effective.

In fact, it has been suggested that an alternative tele-health delivery method that includes face-to-face interactions may be beneficial for promoting health behaviours (Nery et al., 2013). Unfortunately, barriers such as transportation and accessibility often impede in-person participation for adults with SCI, emphasizing the importance of new strategies that allow at-home participation (Kosma et al., 2005). One way to overcome these barriers is through the use of tele-health video-based interventions. Video-based interventions for health-related topics such as quality of life and pressure ulcers have been studied among adults with SCI (Phillips et al., 2001; Hill et al., 2009; Martinez et al., 2017). However, to date, no such intervention for LTPA promotion has been conducted for this population, and none have been grounded in SDT.

The overall aim of the study was to pilot test an innovative SDT-based eight-week tele-health intervention to promote motivation and LTPA in adults with SCI. Specifically, this aim translated into distinct primary and secondary objectives. First, the proposed pilot RCT aimed to determine if, in comparison to the control group, the intervention group had greater improvements in SDT variables: increases in perceived satisfaction of the three basic psychological needs and autonomous motivation, and decreases in controlled motivation. As a secondary outcome, the proposed intervention aimed to determine if the intervention group reported greater increases in LTPA than the control group. Based on previous findings in the

literature, it was hypothesized that our intervention will have moderate effects on perceived basic psychological needs satisfaction (Fortier et al., 2012) and in autonomous, and controlled motivation (Fortier et al., 2012) for the intervention group compared to the control group. Similarly, for the secondary outcome, we hypothesized that compared to the control group, the intervention group will have moderate effects for LTPA (Arbour-Nicitopoulos et al., 2014).

Methods

Participants

As part of a larger study where recruitment is still ongoing, a purposive sampling method was used to recruit 24 adults with SCI. This sample size was determined by a sample size calculation with alpha set at 0.05. Twelve participants were to be randomized to the intervention group, and 12 to the control group. A recent national comprehensive survey found approximately 67 percent of the Canadian SCI population was found to be male (Noreau et al., 2014). A representative sample was thus recruited with a goal of including 16 males and eight females. Unfortunately, due to timeline restrictions associated with the master's thesis, only a portion of the larger study will be presented in this document. For this thesis, participants included 14 adults with SCI who were randomized as part of the larger study (see figure 1).

Participants were contacted and recruited from outpatient rehabilitation hospitals in Montreal (L'institut de Réadaption Gingras-Lindsay-de-Montréal (N=4) and the Lucie-Bruneau Rehabilitation Center), a local adapted fitness center (VioMax) and the provincial organisations representing persons with SCI (e.g., Moelle épinière et et Motricité Québec). Adults with SCI (n=8) were also recruited from two pre-existing databases of previous research participants, and through the use of social media platforms such as twitter (n=2), where we shared our recruitment poster with various SCI organizations (See Appendix A). Recruitment began in August of 2016

and is still ongoing. For this study, the last participant was recruited mid-May, and completed his 10-week follow-up mid-July 2017. Eligible participants were over the age of 18, have paraplegia, have sustained a SCI at least one-year prior, were minimally active (engaging in less than two bouts of LTPA per week in the last two months), and were able to speak and understand English or French. Furthermore, eligible participants were not amotivated for LTPA as per SDT, meaning they had the intention to become physically active in the next two months. (see Appendix B).

Participants were excluded if they were receiving in-patient rehabilitation services, had been diagnosed with memory impairments, severe communication impairments or severe visual impairments, did not require a mobility device, or had answered yes to one of the questions on the SCI-inclusive physical activity readiness questionnaire (see Appendix C). This pilot RCT was limited to adults with paraplegia who use a mobility device to recruit a more homogeneous sample than if adults with any type or level of SCI were recruited. Additional inclusion criteria required participants to have access to a computer that meets the specific software requirements used in the intervention, and access to internet with adequate bandwidth (or a stable 3G cellular connection in which case we provided them with a wireless internet stick; see Appendix B).

Procedures

Ethical approval for the proposed project was obtained by the research ethics board of the Center for interdisciplinary research in Rehabilitation in Greater Montreal. The rehabilitation hospitals used their database to contact adults with SCI who were no longer receiving rehabilitation. Similarly, MEMO-Qc called a list of their members, and VioMax contacted previous members who may not have been active anymore. The recruitment sites then provided us with a list of potential participants. Two team members (M.R. and K.C) then contacted each

name provided by the recruitment sites and each name on the pre-existing database either by telephone or email. Similarly, participants who expressed interest through social media platforms were contacted.

Prior to the start of the trial, a team member (M.R.) contacted each eligible participant by telephone to assess eligibility using a screening questionnaire (see Appendix B) and gained informed consent (see Appendix D). When a participant was contacted by telephone, a verbal confirmation of informed consent was given, the consent form was signed by a team member (M.R.) and a consent log was kept. Once the participant had given informed consent, a team member (M.R.) scheduled the baseline questionnaire assessment that was completed online using the survey hosting platform Surveygizmo or over the telephone. Once recruited, each participant was attributed a study identification number. Blind, pre-labeled and randomly ordered envelops, with separate sets of envelopes for males and females (1-16 and 1-8 respectively), were created to ensure the groups were properly stratified. The random allocation was determined by an online allocation tool (https://www.randomizer.org/). An offsite member of the research team (K.A.N) created and sealed the envelopes. A different member of the research team (M.R.) then randomized each participant to either the control or intervention condition.

As it was necessary to mail intervention-related materials and train participants on the intervention software, there was a two-week delay between completing the baseline questionnaire and beginning the intervention session. This delay allowed each participant to begin their physical activity counselling at the same time from baseline and standardized the data collection across both groups. To reduce experimenter bias, a research assistant who was blinded to the participants' group allocation contacted each participant at six weeks and 10 weeks post-baseline (i.e., four weeks and eight weeks post start of intervention). Participants completed the

questionnaires either by telephone with help from the research assistant or through the online survey hosting platform, Surveygizmo. Each participant received a $30, $35 and $35 gift card for completing the baseline, six- and ten-week questionnaires respectively.

The control group was asked to continue with their regular routine and told that the LTPA counsellor (K.C.) would contact them at the end of the study. At the end of the study, each participant who was randomized to the control group was contacted by email or by telephone, to schedule one session with the LTPA counsellor (K.C.). Each participant from the control group received one, one-hour physical activity counselling session.

Tele-health Physical Activity Intervention

Participants in the intervention group were given instructions on how to download the Remote Education, Augmented Communication, Training and Supervision (REACTS) online video-based software. A web-cam, and a mobile high-speed internet USB key was mailed if needed. To a help avoid technical difficulties during the intervention sessions, a REACTS account was created and given to each participant, and a research team member (M.R.) scheduled a 30-minute training session on the REACTS software. The training session was scheduled within two weeks after baseline measures were collected. Once the training session was completed, the LTPA counsellor (K.C.) set up one brief introductory session with each participant to allow for introductions, and troubleshoot any remaining problems associated with familiarization to the software before the start of the intervention. Starting two weeks post-baseline, the LTPA counsellor (K.C.) conducted one physical activity counselling session per week for eight weeks, giving a total of eight sessions.

The goal of the intervention was to motivate the participants to engage in LTPA in their home or within their community. The intervention was based in SDT, and as such, the LTPA

counsellor (K.C.) was responsible for fostering a LTPA counselling environment that was supportive of the basic psychological needs. This environment was achieved through interpersonal counselling strategies derived from SDT and the spirit of MI. A toolbox of intervention components related to promoting satisfaction of the basic psychological needs was created to help structure the counselling sessions (See Appendix E). For example, showing empathy and understanding the perspective of the participant aided in fostering relatedness. Autonomy may have been supported by providing choices and giving a rationale for suggestions, and competence may have been fostered by focusing on past success and giving positive feedback on behaviour.

Behaviour change techniques were also included in the intervention toolbox. Strategies such as action planning, self-monitoring and goal setting were implemented to further increase satisfaction of the basic psychological needs, autonomous motivation, and LTPA behaviour. The inclusion of specific behaviour change techniques was chosen based on prior success in the literature. For example, action planning has been shown to be an effective behaviour change technique among adults with SCI (Latimer et al., 2006). Similarly, self-monitoring and reviewing goals have been shown to be strong behaviour change techniques (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). In the spirit of SDT and MI, participant's interests and goals were at the forefront of each session, and thus, the outlined toolbox of intervention components (see Appendix E) was used as a guide and not a set protocol.

The LTPA counsellor (K.C.) was a kinesiologist with training as a lifeguard and in youth and adult level coaching. For this study, and to gain knowledge and experience in creating a need supportive environment, the LTPA counsellor (K.C.) received training in behaviour change, creating social environments to foster the basic psychological needs as per SDT, MI and adapted

physical activity. Before recruitment began, the LTPA counsellor (K.C.) completed an exercise and health psychology graduate course which covered SDT, and included a six-week behaviour change counselling assignment. Additionally, she obtained level one and level two MI training certificates. For adapted physical activity training, she completed a two-day adapted physical activity training course with VioMax. and also completed the SCI-U (http://www.sci-u.ca/sciandyou/player.html) course modules. Finally, the LTPA counsellor (K.C.) received informal training with REACTS from the creator of the software and from the tele-rehabilitation project coordinator at the Lucie-Bruneau Rehabilitation center.

Measures

Demographic information. Participants answered questions concerning a wide range of demographic information (see Appendix F). Information regarding the participants' age, sex, ethnicity, language, marital status, access to adapted vehicle and home, and income sources was collected. Information specific to their SCI such as their cause of SCI, years since SCI, mode of mobility and access to transportation was also collected. Language was dichotomized to English (1) or French (2), and having access to an adapted vehicle and having paid employment were dichotomized as Yes (1) or No (2).

Basic psychological needs satisfaction. The previously validated Psychological Needs Satisfaction in Exercise Scale was used to assess perceived satisfaction of the basic psychological needs for physical activity (Wilson, Rogers, Rodgers, & Wild, 2006; see Appendix F). Participants responded to 18 items on a six point Likert scale ranging from one (false) to six (true). Six items target autonomy (e.g., I feel free to exercise my own way), six items target competence (e.g., I feel capable of completing exercises that are challenging me), and six items that target relatedness (e.g., I feel connected to the people who I interact with while we exercise

together). A total mean score was calculated for autonomy, competence, and relatedness subscales. A higher mean score indicated a greater perceived satisfaction of the combined basic psychological needs. The Psychological Needs Satisfaction in Exercise Scale was found to be reliable as Cronbach's alphas were greater than 0.90 across the three time points.

Autonomous and controlled motivation. The Treatment Self Regulation Questionnaire (TRSQ) was used to assess motivation for LTPA (Levesque et al., 2007). This questionnaire was used because it does not require an individual to be active to assess their LTPA motivation. Participants responded to 15 items on a seven-point Likert scale ranging from one (not true at all), to four (somewhat true), and seven (very true; see Appendix F). Participants answered the questionnaire "The reason I would exercise regularly is" based on three types of motivation posited by SDT. The types of motivation assessed by the items in the questionnaire include: amotivation (e.g., I don't really know why), controlled motivation (e.g., Because I feel pressure from others to do so), and autonomous motivation (e.g., Because I personally believe it is the best thing for my health). A mean score was calculated for autonomous motivation, and controlled motivation for LTPA (Ryan & Connell, 1989). The subscale for autonomous motivation was found to be reliable as Cronbach's alphas were greater than .90 across all three time points. Internal reliability was found to be acceptable for controlled motivation at baseline (Cronbach's alpha = 0.80), however at six (Cronbach's alpha = 0.60), and 10 (Cronbach's alpha = 0.58), weeks post-baseline, reliability was at the lower end of the acceptable range.

LTPA. The self-report seven-day Leisure-Time Physical Activity Questionnaire for adults with SCI was used to assess LTPA (Martin Ginis, Phang, Latimer, & Arbour-Nicitopoulos, 2012; see appendix F). This measure was previously validated among adults with SCI. Participants reported the frequency in days, and the duration in minutes of aerobic and

strength-based LTPA over the last seven days for mild, moderate and vigorous intensity. Frequency (days) and duration (minutes) were multiplied separately for mild, moderate, and vigorous strength training, and mild, moderate, and vigorous aerobic LTPA. Weekly minutes of moderate and vigorous strength training, and moderate and vigorous aerobic LTPA were added for each participant to calculate total moderate to vigorous LTPA (MVPA). Similarly, weekly minutes of mild, moderate, and vigorous strength training, and mild, moderate, and vigorous aerobic LTPA were added for each participant to calculate total LTPA

Data Analysis

Data cleaning. All data analyses were conducted using SPSS v. 23 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). Composite variables were computed for LTPA, autonomy, relatedness, competence and autonomous and controlled motivation. The calculations were prorated to reduce missing data. Univariate outliers were examined by creating a standardized Z-score, where a Z-score greater than ± 3.29 was considered a univariate outlier (Tabachnick & Fidell, 2013). Univariate outlier scores were changed to one unit greater than the next largest score. Next, missing data were examined to determine its pattern. As the amount of missing data was minimal, we chose to use the replaced with last observation carried forward strategy to maximize our sample size without suggesting change (Tabachnick & Fidell, 2013).

Analyses. Once the data was cleaned and imputed, demographic and injury related covariates were examined for each outcome through a correlation matrix. Any identified covariates ($r \geq .25$) were controlled for in the subsequent analyses. A regression analysis approach is recommended for analyzing RCT data (Vickers, 2005). Hierarchical multiple regressions were used to examine to what extent the intervention predicted the outcome (at six-

weeks and 10-weeks), when controlling for baseline levels. For each regression, participants' demographic and injury related covariates were entered in the first block, the baseline scores of the dependent variable in the second block, and finally the group variable in the third block. These analyses were conducted for autonomous and controlled motivation, perceived satisfaction of the basic physiological needs, MVPA and total LTPA. Notably, correlations between all three needs were greater than 0.8, 0.5, and 0.5 at baseline, six weeks, and 10 weeks respectively. Due to this high co-linearity between the three basic psychological needs, we chose to use a combined mean score for the three variables in our analyses.

The differences in variance explained by the model (Δr^2) and the weight of the regressions (standardized betas) were used to evaluate whether the model fit improves between block two and three. A calculation for a Cohen's f^2 measure of effect size (where $f^2 = \frac{\Delta r2}{1-\Delta r2}$) has been suggested for hierarchical multiple regressions (Selya, Rose, Dierker, Hedeker, Mermelstein, 2012), where a f^2 of 0.02, 0.15, and 0.35 represents a small, moderate and large effect size respectively (Cohen, 1992). These values can be converted into proportions of variance (Δr^2) by solving the equation for each Δr^2 value ($\Delta r^2 = \frac{f\,2}{(1+f\,2)}$) that corresponds to the appropriate effect size (Wuensch, 2015). As such, a Δr^2 of 0.02, 0.13, and 0.26 was used to represent a small, moderate, and large effect size respectively. A 95% confidence interval (C.I.) was used to report significance.

Due to the small sample size, two other approaches were performed to provide a comprehensive analysis of the data. First, Hedges' *g* effect sizes were calculated using change scores that were computed for each variable. In addition, the change between baseline, six, and 10 weeks, ($\frac{(follow\ up-baseline)}{baseline} * 100$) was calculated and expressed as a relative change percentage for each outcome variable. A change in percentage greater than 10%, was considered

meaningful. As several participants reported baseline LTPA levels equal to zero minutes (which does not allow for a relative change percentage calculation), it was only performed for the primary outcomes. For total minutes of LTPA and MVPA, an increase in minutes of LTPA that is greater than 20 minutes (one bout of LTPA as per the guidelines; Martin Ginis et al., 2017) was considered meaningful.

Results

Preliminary Analyses

As part of a larger study, adults with SCI were assessed for eligibility, and randomized to either the intervention (N=7), or control (N=7) group (see Figure 1). Adjusting for participant dropout (see Figure 1), 13 adults with SCI were included in our analyses. Demographic and injury related information, and mean scores of each variable by group are shown in Table 1 and 2 respectively.

Demographic and injury related covariates for each outcome were identified using bivariate correlations. Autonomous motivation at six weeks was correlated with age (r=.25), sex (r=.26), and years since SCI (r=-.25), while autonomous motivation at 10 weeks was only correlated with having access to an adapted vehicle (r=.51). Controlled motivation at six weeks was correlated with age (r=.28), and years since SCI (r=-.28), while controlled motivation at 10 weeks was only correlated with sex (r=-.29). At six weeks, perceived satisfaction of the basic psychological needs was correlated with language (r=.41), age (r=.31), and having paid employment (r=.36). At 10 weeks, perceived satisfaction of the basic psychological needs was correlated with language (r=.35), having access to an adapted vehicle (r=-.38), age (r=.83), and sex (r=.25). Total LTPA at six weeks was correlated with language (r=.35), and years since SCI (r=-.35), while total LTPA at 10 weeks was only correlated with having access to an adapted

vehicle (r=-.27). Lastly, at six weeks, MVPA was only correlated with having paid employment (r=-.24), while MVPA at 10 weeks was found to be correlated with having paid employment (r=-.38) and age (r=-.31). These outcome-specific demographic and injury-related covariates were controlled for in the subsequent analyses.

A univariate outlier was found for one participant at baseline for both MVPA and total LTPA. Given that this participant self-reported scores were 1.5 times higher than the next highest scores for MVPA and total LTPA at six and 10 weeks, a decision was made to reduce the participant's scores to an acceptable value. Care was taken to ensure that these reduced scores still highlighted this participant's large gap from the next highest score.

Only a single participant was found to have missing data at the six-week follow up, and another single participant was found to have missing data at 10 weeks. Therefore, their missing values were replaced with the last observation carried forward method. The primary and secondary outcomes were determined to be normally distributed.

Primary Outcomes: SDT Variables

At six-weeks post-baseline, moderate group effects were found when predicting the unique variance of autonomous motivation after controlling for demographic, SCI-related variables and baseline autonomous motivation, $\Delta R^2 = 0.13$. Specifically, intervention participants increased their autonomous motivation by .70 over the control group at six weeks. At 10 weeks, significant, large group effects for autonomous motivation were found, $\Delta R^2 = 0.55$, after controlling for demographic, SCI-related variables and baseline autonomous motivation (see Table 3). At 10 weeks, participants in the intervention group increased their autonomous motivation by 2.24 over the control group. In addition, effects size calculations showed that the experimental group reported a small increase in autonomous motivation at six weeks (Hedges' *g*

= 0.34), and a large increase at 10 weeks (Hedges' g = 1.08), compared to the control group. Relative percent calculations found that at six weeks, three participants in the intervention group, compared to two (out of seven) in the control group reported increases in autonomous motivation. Similarly, at 10 weeks, three adults with SCI who received the intervention had increases in autonomous motivation, whereas only one reported increases in the control group (see table 8 for participants who decreased or had no change).

After controlling for covariates and baseline controlled motivation, very small to no group effects were found when predicting the unique variance of controlled motivation at six weeks, $\Delta R^2 = 0.01$, or 10 weeks, $\Delta R^2 < 0.01$ (see Table 4). Similarly, effect sizes calculations demonstrated that compared to the control group, the intervention group reported a small decrease in controlled motivation at six (Hedges' g = -0.34), and 10 weeks (Hedges' g = -0.36) from baseline. At six weeks, relative change percentages found two participants in both the intervention (n=6) and the control (n=7) groups who reported decreases in autonomous motivation compared to baseline. At 10 weeks, two participants in the intervention group, and four in the control group had decreases in controlled motivation (see table 8 for participants who increased or had no changed).

When predicting the unique variance of perceived satisfaction of the basic psychological needs over baseline, small group effects were found at six weeks, $\Delta R^2 = 0.04$, and at 10 weeks $\Delta R^2 = 0.06$ after controlling for demographic and SCI-related variables (see Table 5). Specifically, compared to the control group, intervention participants reported greater increase in basic psychological needs by .34, and .61 at six and 10 weeks, respectively. Interestingly, medium effect sizes were estimated at six (Hedges' g = 0.55), and 10 weeks (Hedges' g = 0.67) for change in perceived basic psychological needs satisfaction when comparing the intervention

to the control groups. Relative change percentages found that compared to baseline, both the intervention (n=6) and the control (n=7) group had one participant who reported increased satisfaction of the basic psychological needs compared to baseline. Conversely, at 10 weeks, the intervention group had three, whereas the control group only had one participant who increased their perceived satisfaction of the basic psychological needs (see table 8 for participants who decreased or had no change).

Secondary Outcomes: LTPA Variables

After controlling for covariates and baseline LTPA, no group effects were found when predicting the unique variance of total LTPA over the baseline at six weeks, $\Delta R^2 < 0.01$. However, large group effects were found at 10 weeks, $\Delta R^2 = 0.20$ (see Table 6). Specifically, intervention participants increased their total LTPA by 357.61 minutes over the control group at 10 weeks. Additional analysis of effects size found that compared to the control group, the intervention group reported no change in total minutes of LTPA at six weeks (Hedges' $g = 0.16$), and, a large change in total LTPA (Hedges' $g = 1.27$) at 10 weeks from baseline. Similarly, a relative change calculation (considering 20 minutes of physical activity a meaningful increase) found at six and 10 weeks, the intervention group had four, and six adults with SCI respectively (out of six participants total) who increased their total minutes of LTPA. In comparison, the control group had three, and four adults with SCI (out of seven participants total) who increased their LTPA at six and 10 weeks, respectively.

After controlling for covariates and baseline MVPA, no group effects were found on MVPA at six weeks, $\Delta R^2 < 0.01$. At 10 weeks, small group effects were found on MVPA when controlling for MVPA at baseline, demographic, and injury-related variables, $\Delta R^2 = 0.08$ (see Table 7). Compared to the control group participants, intervention participants reported a greater

increase in MVPA by 78.34 minutes at 10 weeks. Similarly, effect size calculations found that the intervention group reported no increase in minutes of MVPA at six weeks (Hedges' $g = 0.02$), however, at 10 weeks, there was a small increase from baseline (Hedges' $g = 0.45$) compared to the control group. A relative change calculation found that three, and five adults with SCI in the intervention group (out of six participants total) increased their MVPA at six and 10 weeks respectively. Conversely, four out of seven adults with SCI in the control group increased their MVPA by more than 20 minutes at both six and 10 weeks.

Discussion

The purpose of this pilot RCT was to determine if individuals who received the eight-week tele-health LTPA counselling intervention had greater improvements in SDT-based variables (primary hypothesis), and LTPA variables (secondary hypothesis) compared to individuals in the control group. Compared to the control group, intervention participants had moderate to large increases in autonomous motivation, small increases in perceived satisfaction of the basic psychological needs, and small to large changes for LTPA. This research was the first to use a SDT and tele-health based intervention to promote LTPA in adults with SCI. As such, the findings have helped establish the effectiveness of conducting SDT and tele-health based LTPA counseling interventions for adults with SCI.

Primary Purpose: SDT Variables

Autonomous motivation. When compared to the control group, the intervention group had moderate and large increases in autonomous motivation at six weeks and 10 weeks, respectively. The results align with our hypotheses and SDT. Due to the novelty of this study in adults with SCI, no SDT-based RCTs are available for comparison. Parallels can be drawn from interventions conducted in populations with mobility impairments, such as overweight women

(Silva et al., 2008) and adults with rheumatoid arthritis (Knittle et al., 2015). SDT-based interventions in these populations also found large, significant effects on autonomous motivation favouring the intervention group over the controls (Silva et al., 2008; Knittle et al., 2015). Results from the current study suggest that SDT-based behavioural interventions can effectively increase autonomous motivation for LTPA in adults with SCI.

Increasing autonomous motivation for LTPA may be particularly important for adults with SCI as recent research has found that autonomous motivation predicted LTPA in this population (Rocchi et al., 2017). Additionally, an online web-survey (N=180) found that motivation was one of the most prevalently perceived barriers, and that this barrier was moderately related to engaging in LTPA. Furthermore, the authors suggest that LTPA interventions should work to enhance "internal perceptions and motivation" (p. 27; Cowan, Nash, Anderson, 2013), emphasizing the importance of autonomous motivation in LTPA promotion. The moderate to large increases in autonomous motivation associated with this intervention suggests that a larger SDT-based intervention among adults with SCI should be conducted to determine its large-scale effectiveness.

Controlled motivation. In contrast to autonomous motivation and our hypotheses, very small to no group effects were found for controlled motivation at six and 10 weeks. Although effects sizes and differences in the relative change percentage between groups were small, mean scores for controlled motivation in the control group were relatively stable over the 10 weeks, while the mean scores for the intervention group trended downwards (see Table 2). Few SDT-based interventions have looked at changes in controlled motivation, but our results appear to be similar to the available literature. For instance, a 12-month behaviour change intervention for overweight women similarly found that compared to the control group, their intervention group

was associated with only small decreases in controlled motivation (Silva et al., 2008), while another intervention with female university students found no intervention effects in the changes of controlled motivation (Edmunds, Ntoumanis, & Duda, 2008). These findings suggest that more research is needed to understand how to change controlled motivation in behavioural interventions for LTPA.

In addition to a lack of significant findings in intervention studies, previous literature has highlighted that the role of controlled motivation is weak in the prediction of LTPA for both the SCI (Rocchi et al., 2017) and general (Teixeira et al., 2012) populations. Therefore, it remains unclear of the importance of controlled motivation in the LTPA context. Future research should investigate the role of controlled motivation, and explore for methods to help reduce controlled motivation in LTPA promotion, not only in adults with SCI, but in the general population.

Perceived satisfaction of the basic psychological needs. When comparing the perceived satisfaction of the basic psychological needs of the intervention to the control group, the intervention group had small increases at six and moderate increases at the 10-week time points, which partly aligns with our hypotheses. Moderate effect size estimates, and relative change percentage found at both time points further support out hypotheses. Although this study was the first to assess the psychological needs in an LTPA intervention among adults with SCI, female participants in an SDT-based exercise class were found to have significantly greater need satisfaction for relatedness and competence, but not autonomy after the 10-week program compared to the control group (Edmunds et al., 2008). In a similar sample, an intervention for overweight women increased autonomy and competence for exercise, however, unfortunately, a measure of relatedness was not included in their analyses (Silva et al., 2008). Results have been

mixed for the basic psychological need satisfaction in SDT-based LTPA, and few studies have examined all three needs.

Due to high collinearity between the three basic psychological needs, we chose to use a mean score for the three variables in our analyses. Aggregating the basic psychological needs has been common in the SDT literature due to the high collinearity (Milyavskaya & Koestner, 2011; Van den Broeck, Vansteenkiste, Hans De Witte, & Lens, 2008). In light of the mixed findings from the studies presented above, we conducted the analyses for each psychological need individually and found no meaningful changes for autonomy and competence. Notably, relatedness had large increases for the intervention group when compared to the control group at six ($\Delta R^2 = .29$) and 10 ($\Delta R^2 = .31$) weeks. This finding is particularly interesting because it has been suggested that for some, participating in LTPA alone may be preferable to a group experience. As such, existing measures of relatedness may not capture this preference (Teixeira et al., 2012). Furthermore, our intervention did not place particular importance on group-based LTPA or specifically ask participants to exercise with others. However, social support was often discussed, which may have encouraged adults with SCI in the intervention group to seek out activities that helped support their need for relatedness. As a result, more research is needed to examine the role of each basic psychological need in LTPA promotion for adults with SCI.

Secondary Purpose: LTPA Variables

Our results are in accordance with our hypothesis. Specifically, no group effects were found for MVPA or total LTPA at six weeks, however, at 10 weeks, small and large group effects were found for MVPA and total LTPA, respectively. Furthermore, all six intervention participants increased their LTPA at 10 weeks. Although this study was the first SDT-based intervention, previous behavioural LTPA interventions have used MI and self-regulatory

strategies to assess changes in total LTPA, and MVPA for adults with SCI (Nooijen et al., 2016; Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006) and physical disabilities (Kosma et al., 2005). Similar interventions conducted among this population have been associated with moderate to large increases in total minutes of LTPA (Kosma et al., 2005; Nooijen et al., 2016), and significant effects on minutes of MVPA specifically (Arbour-Nicitopoulos et al., 2009; Latimer et al., 2006). Unfortunately, none of the previous studies conducted in adults with SCI have compared MVPA and total minutes of LTPA outcomes, suggesting that more research is needed to better understand the preferences and implications of individual LTPA intensities. One online SDT-based intervention for healthy adults similarly examined both MVPA and total LTPA outcomes, where large effects were found for both MVPA and total minutes of LTPA (Friederichs et al., 2016). As these findings conflict with the results from the current study, it may be suggested that adults with disabilities present with unique challenges in LTPA promotion.

Although the current study was the first to use SDT in adults with SCI, one study implemented an SDT-based intervention for adults with rheumatoid arthritis (Knittle et al., 2015). Similar to our results, they found the intervention group to have greater increases in total minutes of LTPA (Knittle et al., 2015). Although they did not explicitly measure MVPA as an outcome, they expressed concern that participants preferred less intensive forms of LTPA, which potentially resulted in less functional benefits at the six-month follow up (Knittle et al., 2015).

Our findings suggest that although it may not match the guidelines, an LTPA outcome that includes mild to moderate intensity activity may better reflect the LTPA interests of adults with SCI. Upon recruitment, participants from our study were not previously engaging in LTPA, and thus likely had lower levels of physical fitness. Although, the specific benefits of mild

intensity LTPA have yet to be confirmed for adults with SCI (Martin Ginis, Arbour-Nicitopoulos, et al., 2010), research has suggested that mild activity may be associated with benefits in those who are deconditioned or who have physical disabilities. In fact, among beginners and those who are the least physically fit, low intensity LTPA may still provide large health benefits while reducing risk (Durstine et al., 2000). Research should explore this unique preference and monitor how future interventions can help beginners, or those with low levels of fitness gradually progress to meeting the recommended MVPA guidelines for adults with SCI.

Theoretical Implications and Practical Applications

To date, no previous study has used a SDT-based intervention to promote LTPA for adults with SCI. As a result, this study extended the generalizability of SDT to the SCI population. It further demonstrated that a need supportive LTPA counselling environment can enhance autonomous motivation among adults with SCI, supporting SDT's tenets. However, more research is needed to explore the role of the basic psychological needs in the promotion of LTPA in adults with SCI given the small effects. This result was unexpected as the LTPA counselling environment was created to foster these needs. One explanation could be that existing measures for the psychological needs do not capture the entire LTPA experience for adults with SCI. An in-depth evaluation of the implementation of the intervention could also indicate whether the intervention was delivered as intended. Overall, this pilot intervention appeared to support the use of SDT as a guiding framework to deliver LTPA interventions to adults with SCI.

In addition to being the first SDT-based intervention, this study was the first to use a video-based tele-health modality to promote LTPA for adults with SCI. Preliminary results from this study suggest that an online video-based intervention can create a need supportive social

environment, to foster autonomous motivation, and to promote LTPA. Additionally, through the use of video-based technology, the current study was able to effectively extend research and services beyond the traditional university and rehabilitation settings, and interventions using the telephone. Future practical applications may include the use of this technology to provide services or face-to-face interventions while reducing barriers related to transportation and accessibility.

Limitations and Future Research

Despite the theoretical and practical implications, our study is not without limitations. The small sample size limits the power of the study and its generalizability to the population. However, this study was a pilot RCT aimed to gather preliminary results to prepare for conducting a larger tele-health and SDT based LTPA counselling intervention. Given the sample size, other designs could have been implemented to test our hypotheses, such as a self-controlled, multiple baseline intervention. Self-reported measures for LTPA may have led to overestimation of LTPA levels. This overestimation appears to be the case for participants in this study as they reported being physically active on the baseline questionnaire despite declaring they were engaging in less than two days of LTPA during the screening phase. Future intervention studies may benefit from using more objective measures, along with self-reported outcomes, to capture the impact of the intervention on LTPA outcomes. In fact, recent interventions have used objective measures such as accelerometers to monitor LTPA outcomes in adults with SCI (Nooijen et al., 2016). However, more research is needed to determine the feasibility of these measures in adults with SCI. Additionally, it is important to note that reliability was on the lower side of the acceptable range for controlled motivation, and thus results should be interpreted with caution.

Furthermore, participants needed to be familiar with using technology, and needed to have access to a relatively powerful computer, limiting the generalizability of our findings. In addition to these limitations, the current intervention only followed participants until the end of the intervention period. Thus, future interventions should include follow-up time points to determine if the effects are sustained post-intervention. Future research should also explore the effects of the intervention on all levels of SCI, as the current study was limited to adults with paraplegia.

Conclusion

Overall, findings from this 8-week LTPA counselling intervention support the use of a SDT and video-based tele-health intervention to promote autonomous motivation and LTPA in adults with SCI. Although these findings are preliminary, this study furthers the current literature as it gives insight into the motivational factors that may provide a better understanding as to how behavioural interventions can promote LTPA among adults with SCI. Additionally, as the first video-based tele-health intervention to promote LTPA in this population, this research highlights the feasibility of video-based technology and will help inform the basis of future studies to promote LTPA in adults with SCI.

Tables and Figures

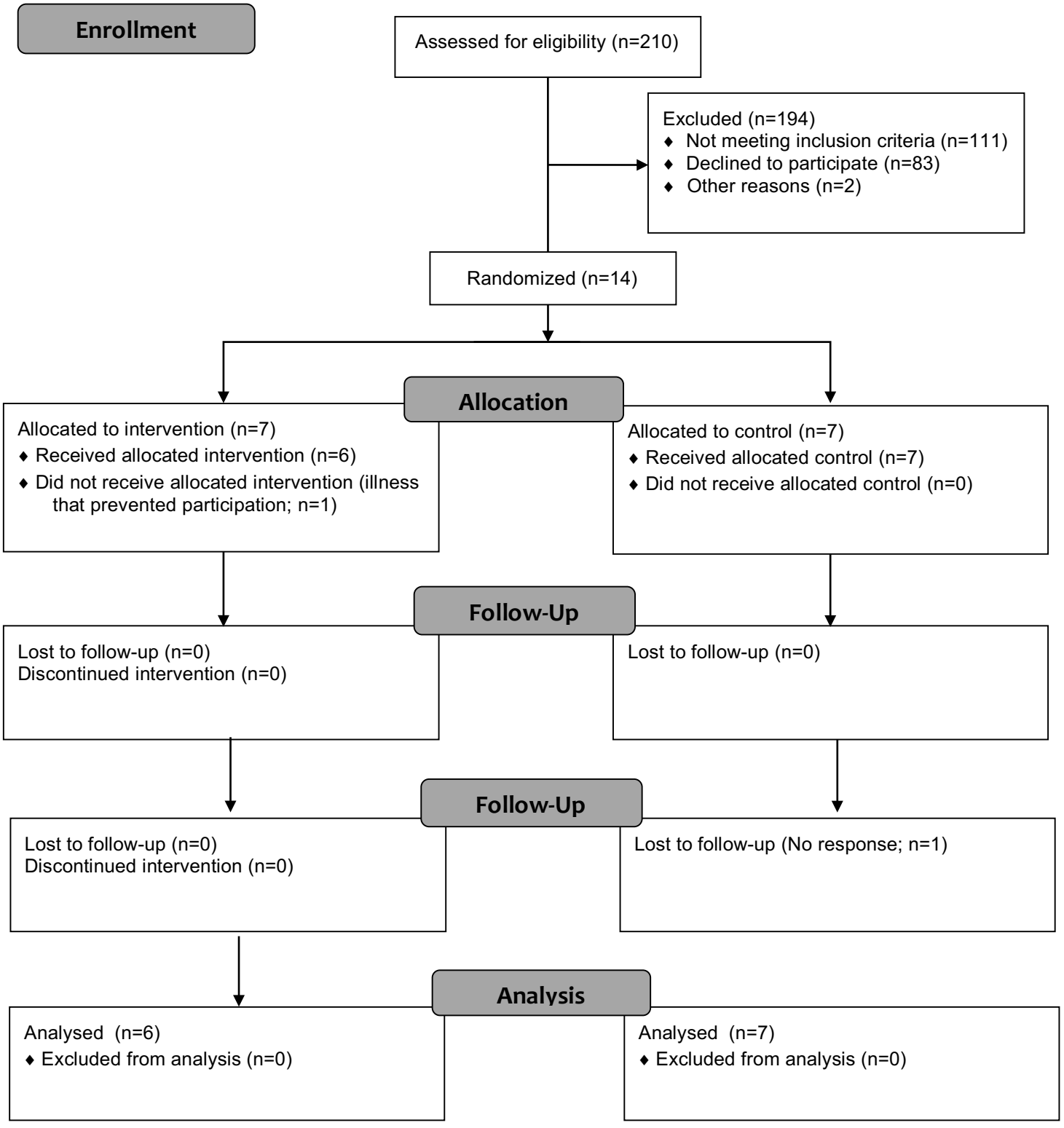

Figure 1. Consort diagram. Flow diagram of the progress through the phases of a two group randomized control trial.

Table 1

Demographic information

Variable	n (%)	*M*	SD
Age (in years), *M* (S.D.)		52.15	13.25
Sex (% male)	11 (84.6)		
Geographical location (% Canadian)	10 (76.9)		
Language (% English speaking)	7 (53.9)		
Ethnicity (% white)	12 (92.3)		
Years since SCI, *M* (S.D.)		13.85	10.35
Mobility mode (% manual wheelchair)	11 (84.6)		
Cause of SCI (% accidental trauma)	9 (69.0)		
% with paid employment	5 (38.5)		
% with access to an adapted vehicle	9 (69.2)		
% with adapted home	12 (92.3)		
% married or common law	11 (84.6)		

Note. Abbreviations: SCI= spinal cord injury. *M*= mean. SD= Standard deviation.

Table 2
Mean scores for autonomous and controlled motivation, perceived satisfaction of the basic psychological needs, moderate and vigorous LTPA, and total LTPA at baseline, six, and 10 weeks.

	Mean scores of variables by group											
	Baseline				Six weeks				Ten weeks			
	Intervention		Control		Intervention		Control		Intervention		Control	
Variable	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD	*M*	SD
AM	5.36	1.81	5.21	1.19	6.28	.94	5.40	.91	6.75	.18	4.64	.79
CM	3.38	1.55	2.76	1.16	2.98	.80	2.76	1.16	2.88	.91	2.82	.67
BSN	4.70	1.04	4.35	1.10	4.72	1.04	4.05	.82	4.83	.74	3.95	.79
Total LTPA	177.50	284.04	170.71	264.77	454.83	547.86	392.43	526.11	658.33	287.52	285.0	238.87
MVPA	57.50	97.46	54.29	86.19	128.17	157.99	127.57	140.19	225.83	151.80	162.14	144.0

Note. Abbreviations: *M*= Mean. SD= Standard deviation. BSN= Basic psychological needs. LTPA= Leisure time physical activity. MVPA= Moderate and vigorous LTPA. CM= controlled motivation. AM=autonomous motivation

Table 3

Multiple regressions models predicting autonomous motivation at six and 10 weeks.

	Autonomous Motivation							
	Autonomous Motivation at 6 weeks				Autonomous Motivation at 10 weeks			
Predictor	ΔR^2	B	ß	95% CI	ΔR^2	B	ß	95% CI
Step 1	.20				.24			
Age		.02	.29	-.03, .07		-	-	-
Sex		.57	.22	-1.24, 2.37		-	-	-
Years since injury		-.03	-.26	-.09, .04		-	-	-
Adapted vehicle		-	-	-		-1.25	-.49	-2.74, .24
Step 2	.17				.01			
Age		.04	.48	-.02, .09		-	-	-
Sex		.44	.17	-1.31, 2.18		-	-	-
Years since injury		-.02	-.16	-.08, .05		-	-	-
Adapted vehicle		-	-	-		-1.28	-.50	-2.87, .31
AM baseline		.32	.47	-.91, .84		-.07	-.09	-.60, .46
Step 3	.13				.55*			
Age		.03	.42	-.02, .07		-	-	-
Sex		.45	.17	-1.27, 2.16		-	-	-
Years since injury		-.01	-.11	-.08, .05		-	-	-
Adapted vehicle		-	-	-		.23	.09	-.90, 1.35
AM baseline		.30	.44	-.21, .81		-.05	-.05	-.34, .25
Group		.70	.37	-.54, 1.94		2.24*	.94*	1.21, 3.28
R^2 (adj R^2)	.70 (.13)				.89 (.80)			
n	13				13			

Note. * p value <0.05 findings. AM= Autonomous motivation. CI= Confidence interval. B= unstandardized beta coefficient. ß= standardized beta coefficient.

Table 4

Multiple regression models predicting controlled motivation at six and 10 weeks.

	Controlled motivation							
	Controlled motivation at 6 weeks				Controlled motivation at 10 weeks			
Predictor	ΔR^2	B	ß	95% CI	ΔR^2	B	ß	95% CI
Step 1	.23				.08			
Age		.03	.44	-.01, .08		-	-	-
Sex		-	-	-		-.58	-.29	-1.85, .70
Years since injury		-.03	-.26	-.01, .03		-	-	-
Step 2	.31				.02			
Age		.03	.44	-.01, .07		-	-	-
Sex		-	-	-		-.52	-.26	-1.90, .86
Years since injury		-.01	-.08	-.06, .04		-	-	-
CM baseline		.43*	.59*	.04, .83		.07	.13	-.31, .46
Step 3	.01				.00			
Age		.03	.45	-.01, .07		-	-	-
Sex		-	-	-		-.52	-.26	-2.00, .96
Years since injury		-.01	-.08	-.06, .05		-	-	-
CM baseline		.45*	.61*	.02, .88		.07	.12	-.36, .50
Group		-.18	-.10	-1.26, .89		.03	.02	-1.04, 1.11
R^2 (adj R^2)	.74 (.32)				.32 (-.20)			
n	13				13			

Note. * p value <0.05 CM= controlled motivation. CI= Confidence interval. B= unstandardized beta coefficient. ß= standardized beta coefficient. A negative R^2 indicates poor model fit.

Table 5

Multiple regression models predicting the perceived satisfaction of the basic psychological needs at six and 10 weeks.

	Perceived satisfaction of the basic psychological needs							
	BSN satisfaction at 6 weeks				BSN satisfaction at 10 weeks			
Predictor	ΔR^2	B	ß	95% CI	ΔR^2	B	ß	95% CI
Step 1	.28				.55			
Age		.01	.19	-.04, .07		-.01	-.14	-.07, .05
Sex		-	-	-		1.39	.61	-.52, 3.31
Adapted Vehicle		-	-	-		-.65	-.36	-1.74, .44
Language		.73	.45	-.78, 2.24		1.38	.83	-.33, 3.09
Paid employment		-.26	-.16	-1.53, 1.00		-	-	-
Step 2	.59				.16			
Age		.01	.18	-.01, .04		<.01	.06	-.05, .06
Sex		-	-	-		.71	.31	-1.18, 2.60
Adapted Vehicle		-	-	-		-.48	-.26	-1.47, .51
Language		.32	.19	-.40, 1.03		.74	.45	-.96, 2.44
Paid employment		.06	.04	-.54, .66		-	-	-
BSN baseline		.66*	.80*	.41, .91		.40	.48	-.09, .90
Step 3	.04				.06			
Age		.01	.19	-.01, .04		<.01	.06	-.05, .06
Sex		-	-	-		.63	.27	-1.28, 2.54
Adapted Vehicle		-	-	-		.04	.02	-1.41, 1.49
Language		.23	.14	-.44, .90		.41	.25	-1.43, 2,25
Paid employment		.07	.04	-.48, .61		-	-	-
BSN baseline		.85	.77	-.17, 1.86		.45	.53	-.06, .96
Group		.34	.21	-.12, .80		.61	.37	-.65, 1.87
R^2 (adj R^2)	.95 (.84)				.87 (.53)			
n	13				13			

Note. * p value <0.05 BSN= Basic psychological needs. CI= Confidence interval. B= unstandardized, ß= standardized beta coefficient.

Table 6

Multiple regression models predicting total LTPA at six and 10 weeks.

	Total LTPA (aerobic and strength LTPA)							
	Total LTPA at 6 weeks				Total LTPA at 10 weeks			
Predictor	ΔR^2	B	ß	95% CI	ΔR^2	B	ß	95% CI
Step 1	.19				.09			
Language		397.57	.40	-232.94, 1028.08		-	-	-
Years since injury		-10.87	-.22	-42.48, 20.74		-	-	-
Adapted vehicle		-	-	-		-194.72	-.30	-613.16, 223.72
Step 2	.63*				.24			
Language		-11.86	-.01	-241.68, 896.25		-	-	-
Years since injury		-13.97	-.28	-30.19, 2.25		-	-	-
Adapted vehicle		-	-	-		-276.64	-.42	-669.44, 116.17
LTPA baseline		1.76*	.90*	1.04, 2.48		.61	.51	-.11, 1.33
Step 3	<.01				.20			
Language		-17.99	-.02	-375.54, 351.82		-	-	-
Years since injury		-13.83	-.28	-31.53, 3.88		-	-	-
Adapted vehicle		-	-	-		-21.70	-.03	-478.98, 435.57
LTPA baseline		1.76*	.90*	.98, 2.55		.49	.41	-.17, 1.15
Group		20.16	.02	-343.14, 383.45		357.61	.59	-52.92, 768.13
R^2 (adj R^2)	.90 (.72)				.73 (.38)			
n	13				13			

Note. * p value <0.05. LTPA= Leisure time physical activity. CI= Confidence interval. B= unstandardized beta coefficient. ß= standardized beta coefficient.

Table 7

Multiple regression models predicting MVPA at six and 10 weeks.

	Moderate and vigorous LTPA							
	MVPA at 6 weeks				MVPA at 10 weeks			
Predictor	ΔR^2	B	ß	95% CI	ΔR^2	B	ß	95% CI
Step 1	.06				.18			
Age		-	-	-		-2.25	-.21	-9.67, 5.18
Paid employment		-68.18	-.24	-249.00, 112.64		-89.34	-.31	-283.72, 105.04
Step 2	.27				.27			
Age		-	-	-		-3.45	-.32	-10.10, 3.20
Paid employment		-45.87	-.16	-210.50, 118.77		-55.26	-.19	-230.03, 119.51
MVPA baseline		.85	.52	-.11, 1.80		.88	.53	-.08, 1.84
Step 3	<.01				.08			
Age		-	-	-		-3.75	-.34	-10.44, 2.95
Paid employment		-46.11	-.16	-223.20, 130.99		-60.62	-.21	-236.21, 113.97
MVPA baseline		.85	.52	-.17, 1,86		.87	.53	-.08, 1.83
Group		2.27	.01	-168.57, 173.11		78.34	.28	-80.07, 236.74
R^2 (adj R^2)	.57 (.10)				.73 (.29)			
n	13				13			

Note. LTPA= Leisure time physical activity. MVPA= Moderate and vigorous LTPA. CI= Confidence interval. B= unstandardized beta coefficient. ß= standardized beta coefficient.

Table 8. *Relative change percentage between baseline and six, and 10 weeks for the primary outcomes*

	Relative Percent (%) Change					
	Intervention (n=6)			Control (n=7)		
Primary outcomes	% change increase	% no change	% change decease	% change increase	% no change	% change decrease
Autonomous motivation at 6 weeks	40.00% 141.18% 27.27%	-4.41% 0.00%	-17.07%	75.00% 17.14%	3.23% -5.41% -2.78% -0.06%	-25.00%
Autonomous motivation at 10 weeks	135.29% 36.67% 81.82%	-4.88% 0.49% 0.00%		87.50%	3.16% 9.38%	-34.29% -31.25% -29.73% -25.00%
Controlled motivation at 6 weeks	38.10% 23.08% 50.00%	-7.14%	-48.65% -39.39%	17.65% 23.08% 25.00%	4.35% 0.10%	-28.57% -20.00%
Controlled motivation at 10 weeks	30.00% 28.57%	-3.57% 0.00%	-33.33% -48.65%	17.76% 112.50% 180.00%		-28.57% -11.54% -13.04% -50.00%
Basic psychological needs satisfaction at 6 weeks	17.15%	-2.13% 1.45% 3.74% 0.00%	-10.29%	22.30%	-9.36% -5.14% 7.06% -0.07%	-10.34% -25.23%
Basic psychological needs satisfaction at 10 weeks	10.98% 14.08% 13.87%	0.00% -1.90%	-11.34%	+34.84%	-3.86% 1.29%	-14.38% -25.25% -16.36% -21.87%

Note. The % change for each participant are reported based on a 10% change cut-off

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Appendices

Appendix A

Online Recruitment Documents

ENHANCING QUALITY OF LIFE THROUGH EXERCISE IN ADULTS WITH SPINAL CORD INJURY

GOAL OF THE RESEARCH

Examine the relationship between physical activity and quality of life through a physical activity promotion intervention.

WE ARE LOOKING FOR ADULTS WHO

1) Have paraplegia,
2) Have sustained an injury at least 1 year prior,
3) Have the intention to become physically active in the next 2 months or **have been minimally active (<2 times per week) in the past 2 months,**
4) Have access to a computer,
5) Are able to speak and understand either English or French,
6) Are not receiving in-patient rehabilitation services,
7) Have not been diagnosed with memory impairments, severe communication difficulties and/or severe visual impairments,
8) Require a mobility device (i.e., wheelchair, cane)

WHAT WE ARE ASKING FROM YOU

- You will be randomly placed into one of two groups.
- In one group (intervention), you will have one physical activity counselling session per week for 8 weeks. You will discuss ways to become physically active. Sessions will be online using the internet and a video-chat software. You will be participating in the intervention from the comfort of your own home!
- In the other group (control), you will be asked to continue with your regular routine. However, you will have access to one 1-hour physical activity counselling session after the study is complete.
- You will also be asked to complete a 30 minute questionnaire at 3 different time points over an 8-week period.

YOU WILL RECEIVE

A $30, $35 and $35 gift card for completing the questionnaires at the three time points respectively.

FOR MORE INFORMATION:

Do not hesitate to contact the research team (Primary Investigator Dr. Shane Sweet) at:
Phone number: 514-398-4184 ext. 0481 or 514-264-1586
or Email: tielabstudy.kpe@mcgill.ca

UNIVERSITY OF TORONTO McGill Université de Montréal

AMÉLIORATION DE LA QUALITÉ DE VIE PAR L'EXERCICE CHEZ LES ADULTES ATTEINTS D'UNE LESION MÉDULLAIRE

BUT DE LA RECHERCHE

Examiner la relation entre l'activité physique et la qualité de vie au moyen d'une intervention visant la promotion de l'activité physique.

NOUS RECHERCHONS DES ADULTES QUI

1) Sont paraplégiques;
2) Ont subi une blessure au moins un an auparavant;
3) Ont l'intention de devenir physiquement actifs au cours des deux prochains mois ou qui ont été minimalement actifs (moins de deux fois par semaine) au cours des deux derniers mois;
4) Ont accès à un ordinateur;
5) Parlent et comprennent le français ou l'anglais;
6) Ne reçoivent pas de services de réadaptation en établissement;
7) N'ont pas reçu de diagnostic de troubles de mémoire, de difficultés graves de communication ou de troubles visuels graves;
8) Ont besoin d'une aide à la mobilité (fauteuil roulant, canne).

CE QUE NOUS VOUS DEMANDONS

- Vous serez placé au hasard dans l'un des deux groupes.
- On demandera à un groupe (groupe d'intervention) de participer à des séances de counseling en activité physique à raison d'une séance par semaine pendant huit semaines. Au cours de ces séances, vous discuterez de diverses façons de devenir actif physiquement. Vous participerez à l'intervention dans le confort de votre foyer!
- On demandera à l'autre groupe (groupe témoin) de maintenir sa routine quotidienne. Si vous faites partie de ce groupe, vous aurez toutefois accès à une séance de counseling en activité physique d'une heure une fois l'étude terminée.
- On vous demandera également de prendre 30 minutes pour remplir un questionnaire à trois moments au cours d'une période de 10 semaines.

VOUS RECEVREZ

Une indemnité compensatoire de $30, $35 et $35 pour remplir les trois questionnaires.

POUR DE PLUS AMPLES RENSEIGNEMENTS

N'hésitez pas à communiquer avec l'équipe de recherche
(Shane Sweet, Ph.D, chercheur principal)
Numéro de téléphone : 514 398-4184, poste 0481
Courriel : tielabstudy.kpe@mcgill.ca

University of Toronto · McGill · Université de Montréal

Appendix B

Screening Questionnaire

1. Do you currently participate in 20 minutes or more of moderate to vigorous intensity physical activity in your leisure/free time on two or more days a week?
   - ○ Yes
   - ○ No

2. Please tell me which of the following statements best describes you:
   - o I don't see why I should have to increase my physical activity
   - o I want to increase my physical activity, but not in the next two months.
   - o I want to increase my physical activity in the next two months.

3. Do you have access to a computer?
   - ○ Yes
   - ○ No

4. Are you capable of speaking and understanding either English or French?
   - ○ Yes
   - ○ No

5. Have you ever been told that you suffer from any cognitive impairments, memory disorder, severe communication difficulties and/or severe visual impairments?
   - ○ Yes
   - ○ No

6. Are you at least 18 years of age?
   - ○ Yes
   - ○ No

7. Do you have paraplegia?
   - ○ Yes
   - ○ No

8. Have you sustained a spinal cord injury at least one year ago?
   - ○ Yes
   - ○ No

9. Have you been told by a health care professional that you cannot participate in physical activity?

- ○ Yes
- ○ No

10. Are you receiving in-patient rehabilitation services?

- ○ Yes
- ○ No

11. Do you require a mobility device (ie. Wheelchair, cane)?

- ○ Yes
- ○ No

12. Do you think exercise is a waste of time?

- ○ Yes
- ○ No

Appendix C

Physical Activity Readiness Questionnaire (PAR-Q+)

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

General Health Questions

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**yes**	**no**
1) Has your doctor ever said that you have a heart condition ☐ OR high blood pressure ☐?		
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?		
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).		
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?		
5) Are you currently taking prescribed medications for a chronic medical condition?		
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active?		
7) Has your doctor ever said that you should only do medically supervised physical activity?		
8. Do you have a spinal cord injury?		
8a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)		

8b. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?		
8c.Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?		

Appendix D

Information Letter and Consent Form

1. Project Title

Enhancing Quality of Life Through Exercise: A Tele-Rehabilitation Approach

2. Principal Investigator

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4. Funding Agency

This research study is funded by: The Craig H. Neilsen Foundation

5. Introduction

You are invited to participate in a research study involving adults with paraplegia and their physical activity and quality of life. Before agreeing to participate in this study, please take the time to read and carefully consider the following information.

This consent form explains the aim of this study, the procedures, advantages and inconvenience as well as the persons to contact, if necessary.

This consent form may contain words that you do not understand. We invite you to ask any question that you deem useful to the researcher and the other members of the staff assigned to the research study and ask them to explain any word or information which is not clear to you.

6. Project Description and Objectives

The study aims at evaluating the effects of a tele-rehabilitation intervention to promote physical activity in adults with spinal cord injury and specifically paraplegia. In the framework of a randomized control trial, 24 adults with paraplegia will be recruited to participate in the study and will be randomly assigned to either the control or intervention group. The overall duration of the study is 10 weeks.

The objectives will be to test a video-based tele-rehabilitation intervention aimed to enhance physical activity and quality of life-related variables (i.e., life satisfaction, participation and depressive symptoms) among adults with spinal cord injury.

7. Nature and Duration of Participation

Once recruited in the study, using a computer program, each participant will be randomized into 2 groups; the intervention group and the control group. This means, you will have equal chance of being recruited into either group. Both groups will answer an online questionnaire at 3 different time points (0, 6 and 10 weeks). The questionnaire will take approximately 30 minutes to complete each time. You may complete the questionnaire either online or by telephone with a research assistant.

Intervention group: If you are randomized to the intervention group, you will be asked to participate in one, 1-hour physical activity counselling session per week for 8 weeks, totaling 8 motivational intervention sessions. These sessions will be done online using the internet and a

video-chat software, meaning you will be participating in the motivational intervention from the comfort of your own home. Before starting the motivational intervention, the research team will provide you with a webcam and/or mobile internet equipment (if required) and will train you on the video-chat software used for the motivational intervention. The motivational intervention will therefore start one to two weeks after you completed the first questionnaire. During the motivational intervention sessions, you will be discussing ways to become physically active either at home or within your community with a trained physical activity counsellor. The goal of these sessions will be to guide you in starting to be physically active. They will provide you with tools and strategies to help you with your physical activity. It is important to know that the motivational intervention is not a standard program, but adapted to your needs. Should you agree, your sessions could be audio and video recorded to further assess the effectiveness of the motivational intervention. Your participation in this study does not involve partaking in a specific physical activity program. Participating in physical activity will remain your choice and will not be imposed by the research team.

Control group: If you are randomized to the control group, you will be asked to continue with your regular routine without any incentive to start a physical activity program for the entire 10 weeks. Once you have completed the questionnaire at 10 weeks, you will be eligible to take part in a meeting with the physical activity counsellor to discuss your physical activity. Please note that these sessions will not be included as part of the research.

It is very important for you to let the researchers know if you have ever been told by a health care practitioner not to participate in strenuous physical activities. If you have, you are ineligible for this study. The research team will make every effort to minimize the occurrence of such risks by educating you on these inconveniences.

8. Personal Benefits from Participating in the Research Study

As a participant, you can pride yourself in knowing that you are contributing to a novel study involving physical activity and quality of life in adults with spinal cord injury. Through your involvement, you are enabling a research study in which the findings may have an important impact on the advancement of our understanding of strategies to increase physical activity among adults with paraplegia. The results will also enhance the science in this field. The scientific community and society may benefit by being able to expand its knowledge about quality of life and physical activity of adults with spinal cord injury.

As a participant in the intervention group (if randomized to this group), you may obtain benefits of the research study by learning strategies to increase your physical activity. Also, you may derive indirect benefits from participating in this study if you engage in more physical activity. Indirect benefits may include increases in energy, strength and endurance, motivation and, potentially, improvements in mobility.

As a participant in the control group (if randomized to this group), you may benefit from having the opportunity to learn the strategies to increase your physical activity at the end of the study. These strategies could then be used to increase your physical activity thereafter, and derive indirect benefits from participating in this study.

9. Inconveniences Associated with Participating in this Research Study

INCONVENIENCES
While the probability is low, participating in this research study could result in potential physical or emotional discomforts.

Emotional discomfort: You may feel uncomfortable answering some questions of the questionnaire. Please note that you do not need to answer a question that you do not want to answer or that makes you feel uncomfortable. You do not have to give the reason why you chose not to answer a particular question. You can continue to participate in the study even if you do not answer all the questions. Please talk with a member of the research team should this discomfort become a concern. In this case, the research team member can provide you with a list of resources.

Physical discomfort: As a result of this study you may choose to engage in physical activity. Indirect to the study itself, there is a small possibility that participating in physical activity may cause light-headedness, fainting, breathing discomfort, temporary changes in blood pressure and/or injury. Physical activity can also cause muscle fatigue during the activity and soreness on one or more days following. This is a normal reaction to physical activity that many people experience. Generally, this soreness is temporary and not harmful to you. Please talk with a member of the research team should this discomfort become a concern. In this case, the research team member can provide you with a list of resources.

10. Access to Results at the End of the Research

At the end of the study, the research team will provide you with a summary of the general results from this research study.

11. Confidentiality

All personal information gathered about you during the study will be coded in order to ensure its confidentiality. Only the members of the research team and their research assistants will have access to the data (contact information, questionnaires and video-audio recordings). However, for monitoring purposes, your research file could be consulted by a person appointed by the CRIR REB institutions or the Ethics Director of the Department of Health and Human Social Services of Quebec, which adheres to a strict privacy policy. All electronic data will be securely stored on a password-protected computer/tablet. Paper copies of consent forms and study questionnaires will be kept in a locked file cabinet in the locked laboratory of Shane Sweet, Ph.D., at the Currie Gymnasium of McGill University. The data will be kept for a five (5) year period after publication of the main results. After that period, all data and files will be deleted/destroyed.

The results from this study will be published in academic journals, presented at scientific conferences and to members of spinal cord injury community. Your name will never be disclosed in any of these publications or presentations.

12. VIDEO AND/OR AUDIO RECORDING

If you are randomized to the intervention group, the physical activity counselling sessions can be video/audio recorded, but only with your permission. If you agree, these recordings will be used to validate the effectiveness of the intervention and can be used in future training sessions. If you indicate your consent to video/audio recordings by checking "yes" below, you maintain the right to withdraw your consent at any time during the study. However, your previously recorded sessions will be kept unless you indicate otherwise to the research team. If you check "no" below, we will not record the physical activity counselling sessions. It is not necessary to consent to this section in order to participate in the research study.

Do you consent to video/audio record the physical activity sessions for the purpose of effectiveness evaluations and training sessions?

Yes ☐ No ☐

13. VOLUNTARY PARTICIPATION AND RIGHT OF WITHDRAWL OF THE SUBJECT

Your participation to the research study described above is completely voluntary. It is understood that you can, at any time, put an end to your participation. To withdraw from participation, you are simply to communicate this verbally to any member of the research team. In case of withdrawal on your part, the audiovisual and written documents concerning you will be destroyed if that is your decision.
By withdrawing from the study, you will not be asked to return the compensation you have received up until your withdrawal.

14. FURTHER STUDIES

It may be that the results obtained following this study result in another research study. In this case, do you authorize the research team of this study to contact you to determine if you would be interested in participating in this new study?

☐ no
☐ yes for a duration of one year*
☐ yes for a duration of two years *
☐ yes for a duration of three years *

* Note that if you select one of these three options, your personal information will be kept by the principal investigator for the period to which you have consented

15. RESPONSIBLITY CLAUSE

While agreeing to participate in this study, you do not give up any of your legal rights nor release the researchers, sponsors or institutions involved of their legal and professional obligations.

16. COMPENSATORY INDEMNITY

You will receive up to $100 in compensation for your time and any inconveniences or constraints you may experience while participating in the research study. Specifically, you will receive $30, $35 and $35 for completing the baseline, 6- and 10-week questionnaires respectively.

17. CONTACT PERSONS

If you have questions concerning the research study, if you wish to withdrawal from the study or if you would like to make the research team aware of an incident, you may contact: Dr. Shane Sweet, Assistant Professor, McGill University, at 514-398-4184 X09903 or by email Shane.Sweet@mcgill.ca.

If you have any questions about your rights and recourse or your participation in this research study, you can contact Me Anik Nolet, Research Ethics Co-ordinator for the CRIR'S Institutions at (514) 527-4527 extension 2649 or by e-mail anolet.crir@ssss.gouv.qc.ca. Questions can also be directed to the local complaints and quality of services departments at the Jewish Rehabilitation Hospital and the Centre de Réadaption Lucie-Bruneau.

18. CONSENT

I state that I have read this consent form. I understand this study, the nature and extent of my participation, as well as the benefits and inconveniences to which I will be exposed as presented in this form. I have been given the opportunity to ask questions concerning any aspects of the study and have received answers to my satisfaction.

I, the undersigned, voluntary agree to take part in this study. I can withdraw from the study at any time without prejudice of any kind. I certify that I have had sufficient time to consider my decision to participate in this study.

A signed copy of this consent form will be given to me.

NAME OF PARTICIPANT (print) SIGNATURE OF PARTICIPANT

_____ _____

Signed at _____ , the _____, 20 _____."

19. RESPONSIBILITY OF THE PRINCIPAL INVESTIGATOR

I, the undersigned, _____, certify
(print)

(a) having explained to the research participant the terms of this form
(b) having answered all the questions he/she as asked in this regard
(c) having clearly indicated that he/she remains free, at any time, to end his/her participation in the above described research study
(d) that I will give him/her a signed and dated copy of this form.

_____
Signature of the Principal Investigator or representative

Signed at _____, the _____ 20 __."

Appendix E

Intervention Components

Intervention Component	BCT	Description	Example	Needs	Why
Use autonomy supportive phrases instead of controlling language		Provide opportunities for adults input by including interactions that involve asking the individual what he or she wants to achieve. Avoid coercion or guilt inducing phrases to minimize control and pressure.	Ask the adult to provide input or make choices when providing advice. "How many days would you like to exercise?" rather than "You should do aerobic exercise two days a week"	Autonomy	Freedom to determine one's own actions, behaviour, etc
Maximize adults' choice		When the adult is ready to accept advice, provide choices	Ask the adult if he or she is ready to consider advice regarding activities outside the clinic. "There are a number of things you can do that will help… would you like to hear a few suggestions?"	Autonomy	Allows the adults to select the option/choice that is most meaningful to them
Provide a rationale for suggestions		Explain to the adult the rationale behind your	"If you complete these exercises then you'll strengthen	Autonomy	Provides information for adults to make an educated choice

		advice and/or choices	your arms and it will be less likely to give you pain"		
Advise the adults to express the pros and cons	9.2	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour	"What do you think are the pros of exercising with SCI? What are the cons?"	Autonomy	Allows for adults to gain perspective on the task to make an informed decision to change
Assist in identifying barriers and obstacles		Discuss at least one likely barrier to following treatment advice	"Is there anything you can think of that might stop you from accomplishing your exercise goal?"	Autonomy	Allows for adults to gain perspective on the task and identify barriers most important to them.
				Competence	Adults acknowledge barriers and obstacles will come with PA and will be prepared to overcome them
Assist in coping planning and problem solving	1.2	Encourage adults to think of ways to overcome barriers	"If the weather is bad, how could you remain active?"	Autonomy	Provides opportunities for adults to have input on how to overcome barriers in a way that works for them
				Competence	Provides adults with understanding of how to cope with barriers
Tailor each session to the individual		Individualize each session to the demands of the adults	Tailor advice and support	Autonomy	Adults receive appropriate and timely intervention components when is best for them
Involve adults in every decision related to their physical activity		Ask the adult for his/her opinions/comments during the intervention. Take into	"How many days of the week would you like to exercise?" "What days of the week can	Autonomy	Adults become involved and in control of the decisions on their behaviour change

throughout the intervention		account the adults subjective history (e.g. family/work commitments).	you find time to do PA?" "What is the best time to do PA on those days?" "What specific exercise will you do?" "How long will you exercise for?"		
Self-monitoring of weekly daily activities		Provide a resource where the adult records all activities conducted each day for a 7-day period including PA, sedentary time, eating/preparing meals, personal hygiene, and self care activities	Adults will record all information in a day planner including the time and how long activities take	Autonomy	Provides a means for adults to visualize where they feel they can fit PA
Providing a physical activity Diary	2.3	Establish a method for the adult to monitor and record their behaviour	Provide adults with rehabilitation diary to help him/her keep track of home based physical activity	Competence	Provides adults with a means to see their progression throughout the intervention and stay informed on the progress of their goal. Prior experience could be a source of self-efficacy

Assist in action planning	1.4	Prompt detailed planning of performance of the behaviour (must include at lease one of context, frequency, duration, and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive) (includes implementation interventions).	"How many days of the week would you like to exercise?" "What days of the week can you find time to do PA?" "What is the best time to do PA on those days?" "What specific exercise will you do?" "How long will you exercise for?"	Autonomy/ Competence	Provides opportunity for adults to create a detailed schedule that works for them/ Allows adults to feel confident they can stick to their physical activity schedule
Assist in goal setting based on the SMART principle	1.1	Assist in setting goals that are Specific, Measureable, Achievable, recorded, and Time-Based	"Earlier you had mentioned that you are finding it hard to exercise for long periods. How many minutes of exercise per day do you think we could set as a target for this week? How many days do you think you could achieve that target in the next week?"	Autonomy/ Competence	Provides opportunity for adults to create appropriate goals based on what they feel works for them/ Adults become aware of what is realistic and achievable in terms of physical activity

Provide positive feedback (feedback on behaviour)	2.2	Monitor and provide informative or evaluative feedback on performance of behaviour (form, frequency, duration, intensity). Reward the adults for trying, and stress that a failed try does not mean they are incapable	"Great job exercising this week! Although it was not 3x a week as you had originally planned, it is still a great achievement that you started exercising"	Competence	Provides adults with sense of confidence and/or increases self-efficacy if able to complete a goal or part of a goal
Focus on past success	15.3	Advise to think about or list previous successes in performing the behaviour (or parts of it)	"Describe or list the occasions on the last time you exercised."	Competence	Provides opportunities for adults to acknowledge that they can successfully complete physical activity
Verbal persuasion about past capability	15.1	Tell the adult they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed	"You mentioned that you used to exercise often. If you start slow you will be able to work yourself back up to that level of exercise"	Competence	Provides opportunities for adults to acknowledge that they can successfully complete physical activity
Normalize feelings, behaviours, and experiences (social comparison)	6.2	Draw attention to others' performance to allow comparison with the	"Most people experience pain when beginning to exercise for 2-3 days. This pain will	Competence	Increases adults knowledge of common feelings, behaviours and experiences related to physical activity

		adults own performance	decrease as you exercise more"		
Assist in clarifying outcome expectations		Discuss the outcomes of physical activity including how they feel it may positively or negatively affect overall health and quality of life.	"what do you expect to achieve by becoming more physically active?" "Studies have shown physical activity may increase independence and prevent risk of chronic conditions such as heart disease"	Competence	Adults can better understand the effects of exercise and expect positive outcomes
Discrepancy between current behaviour and goal	1.6	Draw attention to discrepancies between an adults current behaviour (in terms of form, frequency, duration, or intensity of that behaviour) and the adults previously set outcome goals, behaviour goals or action plans	Point out that while their effort was good, the recorded exercise fell short of the goal set	Competence	Allows for adults to see progress in their ability as well as areas for improvement

Review behaviour goals	1.5	Review behaviour goals jointly with the adult and consider modifying goals or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to) the first.	Increase duration, intensity, frequency	Competence	Provides adults with opportunity to seek help in changing goals to make them more realistic. Adults gain control of goals and can understand why aspects of goals need to change
General and practical support	3.1	**General:** Advise on or discuss possible sources of social support (e.g. from friends, relatives, colleagues) or give non contingent praise or reward for physical activity. This includes encouragement and counselling but only when it is directed at	**General:** Arrange for a housemate to encourage continuation with the behavior change program. Invite the adults to contact you in the event of difficulties or questions	Competence	General: Similar to positive feedback, adults will experience sense of confidence and/or increased self-efficacy from people who they value.

		the behaviour. Includes offering the adult contact with the counsellor			
	3.2	**Practical:** Advise on, or provide practical help (from friends, relatives, colleagues) for performing physical activity	**Practical:** Ask the partner of the adults to put their wheelchair beside the bed so that the adult can transfer by themselves		**Practical:** Adults gain an understanding of their limitations and when to ask for help.
Demonstration of behaviour	6.1	Provide a demonstration of the physical activity either in person or indirectly.	Use of film, pictures, for the adults to aspire to or imitate.	Competence	Modelling of vicarious experiences to enhance self efficacy
		Cater for different learning preferences by using a selection of methods to educate the adults	Selection of methods include aural, visual and kinesthetic which can be during session and/or take home materials		
Act in a warm and caring way and avoid judgment or blame		Be respectful of the adult and work to understand them instead of passing judgment.	--	Relatedness	Allows adults to feel comfortable and accepted
Express empathy		Show adults that you understand their	"I can see this upsets you" or "That must be	Relatedness	Adults will feel more connected/related as you understand their view point

		emotions pertaining to the issue being discussed	very frustrating"		
Acknowledge and support adults perspectives, feelings and values		Be conscious of the adults feelings and supportive of their beliefs	"Some people feel intimidated and those feelings are normal"	Autonomy	Allow adults to feel that their feelings and beliefs are valued and their counselling sessions will reflect their personal perspectives
				Relatedness	Adults will feel more connected/related as you understand their view point
Values interview & valued self identity	13.4	Advise the adult to write or express cherished values or personal strengths as a means of affirming the adults identity before they receive a message advocating physical activity	"What would you say are your two most important values in life?" "How could becoming physically active hinder these values? How could it enhance them?"	Autonomy	Allow adults to feel that their identity and values are important, and that the content of their counselling sessions will reflect their personal perspectives
				Relatedness	Allows adults to be more comfortable as you learn more about what is important to them
Use open-ended questions		"Tell me"/"What"/" How" are useful terms when asking questions as they allow the adult to elaborate on his/her story	"What kind of things are you doing to alleviate the pain at the moment"	Relatedness	Open questions offer more space for the adults to come up with their own answers, insights, and reason to change
Staying Silent		Allow the adult to complete	--	Relatedness	Adults feel as though you are listening to what they are saying

		sentences and finish speaking before following up with further questions			and does not feel rushed to finish their sentence/idea
Paraphrasing/ Reflective listening		After listening to the adult, summarize your perception of the main points	"So what I am hearing is that…" or "It sounds like…"	Relatedness	Provides adults with the sense that you are listening and understanding what they are saying
Following up		Suggest a specific follow up appointment, provide guidance regarding when an appointment should be arranged, or inform the adult that no follow up appointment is needed	--	Relatedness	Shows concern or interest in the adults and their progress
				Competence	the appointments will be made based on the availability of the adult
Offering Contact		Invite the adult to contact you in the event of difficulties or questions	--	Relatedness	Provides support showing concern of well being of the adults
Aid in finding their own Resources		Help the adult become autonomous in their ability to search for their own resources	--	Autonomy	Allows the adult to become independent in their ability to find resources
				Competence	allows the adult to feel less dependent on the physical activity counsellor

Appendix F

Demographic Information

Birth date

_____/____/____(YYYY/MM/DD)

Age

_____

Sex

- ○ Male
- ○ Female

Postal Code

_____

Date of SCI

____/____/_____ (YYYY/MM/DD)

Level of SCI

_____

Cause of SCI

_____

Do you know your American Spinal Injury Association (ASIA) Impairment Scale (AIS) classification?

- ○ Yes
- ○ No

If yes, please specify your American Spinal Injury Association (ASIA) Impairment Scale (AIS) classification.

- ○ A
- ○ B
- ○ C
- ○ D
- ○ E

If no, which of the following best describes you?

- ○ No feeling or movement below the level of the injury.
- ○ Feeling all the way down to your rectum/bum but no use of muscles.

- ○ Limited movement or muscle contractions below level of the injury but these serve no useful function.
- ○ Functional, but not necessarily full use of at least half of the muscle groups below the level of the injury.
- ○ Feeling and movement is normal below level of injury.

What is your primary mode of mobility outside your home?

- ○ Manual Wheelchair
- ○ Power Wheelchair
- ○ Walker
- ○ 3 Wheel Mobility Scooter
- ○ Braces
- ○ Cane
- ○ Walk Independently
- ○ Other (please specify) _____

Which of the following describes your ethnicity?

- ○ White
- ○ Native Canadian
- ○ Black
- ○ Asian
- ○ Other (please specify) _____

What is the highest level of education you have completed?

- ○ High School
- ○ College
- ○ University (Bachelor's)
- ○ Post Graduate
- ○ Other (please specify) _____

What is your marital status?

- ○ Single
- ○ Common Law
- ○ Married
- ○ Divorced

- ○ Widowed

Is your home adapted to meet your needs?

- ○ Yes
- ○ No

Transportation:

Do you have access to specialized transit (or paratransit) in your region?

- ○ Yes
- ○ No

Do you believe this transit service meets your needs?

- ○ Yes
- ○ No

Do you own an adapted vehicle?

- ○ Yes
- ○ No

Income source(s): Please indicate the income source types that apply to the personal income
Please choose all that apply:

- ☐ Wage / Salary (i.e., Paid work)
- ☐ Government pension (i.e., Canada/Quebec Pension Plan Retirement Pension)
- ☐ Employer pension
- ☐ Investments
- ☐ Worker's compensation (i.e., Commission de la Santé et de la Sécurité au Travail)
- ☐ Vehicle insurance (i.e., Société de l'assurance automobile du Québec (SAAQ))
- ☐ Financial compensation received through the settlement of a lawsuit (i.e., Injury claim)
- ☐ Provincial program (i.e., Social assistance (Programme d'aide sociale du Québec))
- ☐ Federal program (i.e., Employment Insurance, Canada Pension Plan Disability Benefits)
- ☐ Private Insurance (i.e., Critical Illness insurance, extended health benefits)
- ☐ Provincial Victim Services Funding (i.e., IVAC : Indemnisation des victims d'actes criminels)
- ☐ Other, please specify: _____
- ☐ Prefer not to answer

Appendix G

Measures

TSRQ

The following question relates to the reasons why you would either start to exercise regularly or continue to do so. Different people have different reasons for doing that, and we want to know how true each of the following reasons is for you. All 15 responses are to the one question.

Please indicate the extent to which each reason is true for you, using the following 7-point scale:

1	2	3	4	5	6	7
Not at all true			Somewhat true			Very true

The reason I would *exercise regularly* is:

1. Because I feel that I want to take responsibility for my own health.	1	2	3	4	5	6	7
2.Because I would feel guilty or ashamed of myself if I did not exercise regularly.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
3.Because I personally believe it is the best thing for my health.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
4.Because others would be upset with me if I did not.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
5.I really don't think about it.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
6.Because I have carefully thought about it and believe it is very important for many aspects of my life.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
7.Because I would feel bad about myself if I did not exercise regularly.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
8.Because it is an important choice I really want to make.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
9.Because I feel pressure from others to do so.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10.Because it is easier to do what I am told than think about it.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
11.Because it is consistent with my life goals.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
12.Because I want others to approve of me.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
13.Because it is very important for being as healthy as possible.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
14.Because I want others to see I can do it.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
15.I don't really know why.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury (LTPAQ-SCI)

These next questions ask about the time you spent engaging moderate and heavy intensity leisure time physical activity (LTPA) in the last 7 days during. LTPA is physical activity that you choose to do during your free time, such as exercising, playing sports, gardening, and taking the dog for a walk (necessary physical activities such as physiotherapy, grocery shopping, pushing/wheeling for transportation are not considered LTPA).

*First, please tell us about the **AEROBIC** **activities** you do in your leisure time. This includes the leisure time activities that typically increase heart rate and breathing. These leisure time activities include but are not limited to sport.*

1. Mild intensity aerobic LTPA requires very light physical effort; mild intensity activities make you feel like you are working a little bit, but you can keep doing them for a long time without getting tired…

During the last 7 days, on how many days did you do mild intensity aerobic LTPA? _____

On those days, how many minutes did you usually spend doing mild intensity aerobic LTPA? _____

2. Moderate intensity aerobic LTPA requires some physical effort; moderate intensity activities make you feel like you are working somewhat hard, but you can keep doing them for a while without getting tired…

During the last 7 days, on how many days did you do moderate intensity aerobic LTPA? _____

On those days, how many minutes did you usually spend doing moderate intensity aerobic LTPA? _____

3. Heavy intensity aerobic LTPA requires a lot of physical effort. These activities make you feel like you are working really hard, almost at your maximum. You cannot do these activities for very long without getting tired. These activities may be exhausting.

   During the last 7 days, on how many days did you do heavy intensity aerobic LTPA? _____

On those days, how many minutes did you usually spend doing heavy intensity aerobic LTPA? _____

*Now, please tell us about the **STRENGTH TRAINING** you do during your leisure time. These exercises should work your major muscle groups. This includes exercises such as lifting weights or using elastic resistance bands.*

4. **Mild intensity** strength training requires very light physical effort. Mild intensity activities make you feel like you are working a little bit, but you can keep doing them for a long time without getting tired.

During the last 7 days, on **how many days** did you do mild intensity strength training?

On those days, **how many minutes** did you usually spend doing mild intensity strength training? Please only report the time you are active. Do not include the time you spend recovering between exercises

_____

5. M**oderate intensity strength training** requires some physical effort. Moderate intensity activities make you feel like you are working somewhat hard, but you can keep doing them for a while without getting tired.

During the last 7 days, on **how many days** did you do moderate intensity strength training?

On those days, **how many minutes** did you usually spend doing moderate intensity strength training? Please only report the time you are active. Do not include the time you spend recovering between exercises

_____

6. H**eavy intensity strength training** requires a lot of physical effort. Heavy intensity activities make you feel like you are working really hard, almost at your maximum. You cannot do these activities for very long without getting tired. These activities may be exhausting.

During the last 7 days, on **how many days** did you do heavy intensity strength training?

_____

On those days, **how many minutes** did you usually spend doing heavy intensity strength training? Please only report the time you are active. Do not include the time you spend recovering between exercises _____

Psychological Need Satisfaction in Exercise (PNSE) Scale

The following statements represent different feelings people have when they participate in physical activity. Please answer the following questions by considering **how you typically feel while you exercise.**

False	Mostly False	More false than true	More true than false	Mostly true	True
1	**2**	**3**	**4**	**5**	**6**

1. I feel like I share a common bond with people who are important to me when we exercise together.	**1**	**2**	**3**	**4**	**5**	**6**
2. I feel free to exercise my own way.	**1**	**2**	**3**	**4**	**5**	**6**
3. I feel confident in my ability to perform exercises that personally challenge me.	**1**	**2**	**3**	**4**	**5**	**6**
4. I feel like I have a say in choosing the exercises that I do.	**1**	**2**	**3**	**4**	**5**	**6**
5. I feel that I am able to complete exercises that are personally challenging.	**1**	**2**	**3**	**4**	**5**	**6**
6. I feel attached to my exercise companions because they accept me for who I am.	**1**	**2**	**3**	**4**	**5**	**6**
7. I feel confident I can do even the most challenging exercises.	**1**	**2**	**3**	**4**	**5**	**6**
8. I feel free to choose which exercises I participate in.	**1**	**2**	**3**	**4**	**5**	**6**
9. I feel like I am the one who decides what exercises I do.	**1**	**2**	**3**	**4**	**5**	**6**
10. I feel capable of completing exercises that are challenging me.	**1**	**2**	**3**	**4**	**5**	**6**
11. I feel free to make my own exercise program decisions.	**1**	**2**	**3**	**4**	**5**	**6**
12. I feel like I am in charge of my exercise program decisions.	**1**	**2**	**3**	**4**	**5**	**6**
13. I feel like I am capable of doing even the most challenging exercises.	**1**	**2**	**3**	**4**	**5**	**6**
14. I feel good about the way I am able to complete challenging exercises.	**1**	**2**	**3**	**4**	**5**	**6**
15. I feel a sense of camaraderie with my exercise companions because we exercise for the same reasons.	**1**	**2**	**3**	**4**	**5**	**6**
16. I feel close to my exercise companions who appreciate how difficult exercise can be.	**1**	**2**	**3**	**4**	**5**	**6**

17. I feel connected to the people who I interact with while we exercise together.	**1**	**2**	**3**	**4**	**5**	**6**
18. I feel like I get along well with other people who I interact with while we exercise together.	**1**	**2**	**3**	**4**	**5**	**6**