The Pedometer Project: Using an Individualized Cadence-Based Exercise Prescription (CBEP) to Increase the Amount of Moderate-Vigorous Physical Activity Accumulated by a Cohort of Previously Inactive Adults.

by

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Abstract

This study determined whether a cadenced-based exercise prescription (CBEP) enabled participants to increase the time they spend doing moderate-to-vigorous intensity physical activity (MVPA) to a greater extent than Standard Care (SC). Forty-six participants were recruited from the ENCOURAGE study and were allocated to SC (n=25) or CBEP (n=21). Data was collected at baseline (T0), prior to the intervention (T1) and then again at 16 (T2) and 24 (T3) weeks. Moderate-to-vigorous physical activity was assessed by accelerometry in 10 minute ($MVPA_{10min}$) and sporadic bouts ($MVPA_{Spor}$) as well as step counts ($Steps_{Total,}$ $Steps_{MVPA}$). Although participants reported that CBEP helped them to increase their motivation to become more active, none of the accelerometer parameters differed between SC and CBEP at baseline, 8, 16, or 24 weeks. These data suggest that CBEP did not have an added benefit for influencing physical activity over time amongst a population of previously sedentary adults.

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Dedication

I would like to dedicate my thesis project to my family. I would not be where I am today without their constant support, sacrifice and love. Also, I would like to dedicate this project to my graduate studies advisor Dr. Todd Duhamel. I would not be as successful and fortunate in my current research career if it were not for his mentorship and encouragement to help me reach my full potential as a research scientist.

Abbreviations

6MWT – 6 minute walking test

Age_{young} – age below or equal to 52 years

Age_{old} – age above 52 years

BMI – body mass index

BMI_{over} – BMI over 36 kg/m^2

BMI_{Steps} – Work of moving calculated by multiplying BMI and total steps per day

BMI_{under} – BMI under or equal to 36 kg/m^2

$Cadence_{mod}$ – cadence when target HR at 50% of HRR is achieved

CBEP – cadenced-based exercise prescription

$CBEP_{Individual}$ – Cadenced-Based Exercise Prescription group accelerometer data based on individual cut-points

$CBEP_{Standard}$ – Cadenced-Based Exercise Prescription group accelerometer data based on standard cut-points

CEP – Certified Exercise Physiologist

CFC – Certified Fitness Consultant

CI – confidence interval

CO_2 – carbon dioxide

CPAG – Canadian Physical Activity Guidelines

CSEP – Canadian Society of Exercise Physiology

EMR – Electronic Medical Records

ENCOURAGE – ENhancing primary care COUnselling and Referrals to community-based physical Activity opportunities for sustained lifestyle chanGE

ENREB – University of Manitoba Education/Nursing Research Ethics Board

^{2}H – hydrogen

H_2O - water

HR – heart rate

HR_{max} – maximum heart rate

HR_{rest} – resting heart rate

HRR – heart rate reserve

METs – metabolic equivalents

MET-$min_{Total10min}$ – Total MET-minutes per week in 10 minute bouts

MET-$min_{TotalSpor}$ – Total MET-minutes per week in sporadic bouts

MVPA – moderate-to-vigorous physical activity

$MVPA_{10min}$ – MVPA minutes per week in 10 minute bouts

$MVPA_{AE\text{-}CPAG}$ – met the aerobic exercise recommendation in the Canadian Physical Activity Guidelines based on $MVPA_{10min}$

$MVPA_{Bouts10min}$ – Number of bouts of MVPA performed for 10 minutes or longer per day

$MVPA_{Spor}$ – MVPA minutes per week in sporadic bouts

^{18}O - oxygen

RCT – randomized controlled trial

RFIT – risk factor identification tool

$RFIT_{AE\text{-}CPAG}$ – met the aerobic exercise recommendation in the Canadian Physical Activity Guidelines based on RFIT

$RFIT_{MVPA}$ – MVPA minutes per week based on RFIT

RPE – rating of perceived exertion

SC – standard care

SD – standard deviation

SF-12 – short form-12 health survey

$Steps_{10,000}$ – reached 10,000 total steps per day

$Steps_{MVPA}$ – MVPA steps per day in sporadic bouts

$Steps_{Total}$- Total steps per day in sporadic bouts

T0 – baseline time point

T1 – 8 week time point

T2 – 16 week time point

T2-T1/T1 – percent change from 8 to 16 week time point

T3 – 24 week time point

T3-T1/T1 – percent change from 8 to 24 week time point

T3-T2/T2 – percent change from 16 to 24 week time point

$TotalPA_{10min}$ – Total minutes of physical activity per week in 10 minute bouts or longer

$TotalPA_{Bouts10min}$ – Number of bouts of total physical activity performed for 10 minutes or longer per day

$TotalPA_{Spor}$ – Total minutes physical activity per week in sporadic bouts

VO_{2max} – maximum oxygen consumption

$Weight_{over}$ – weight over 103 kg

$Weight_{under}$ – weight under or equal to 103 kg

YMCA-YWCA – Young Men's and Young Women's Christian Association of Winnipeg Incorporated

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Chapter 1: Literature Review

Physical inactivity is a major issue.

Physical inactivity is the fourth leading cause of mortality in the world [1, 2]. Furthermore, more than 85% of Canadians are not meeting the aerobic exercise recommendation in the Canadian Physical Activity Guidelines (CPAG) of 150 minutes per week of moderate-to-vigorous physical activity (MVPA), performed in 10 minute bouts or longer [3]. In fact, the average Canadian adult spends more than 9 hours a day being inactive [3]. Physical inactivity plays a major role in overall health and can contribute to many chronic conditions, such as ischemic heart disease (30%), type 2 diabetes (27%), and breast and colon cancer (21%) [2]. In addition, inactive individuals have a 30-40% higher risk of all-cause mortality [4-6] and a 4.5 year shorter life expectancy as compared to more physically active individuals [7]. Therefore, it is imperative to develop interventions to enable Canadians to adopt and sustain a more physically active lifestyle.

Canadian Physical Activity Guidelines.

The Canadian Society of Exercise Physiology (CSEP) developed the CPAG with the primary objective to promote the adoption of a more physically active lifestyle amongst Canadians. There are specific CPAG for 5-11 year old children, 12-17 year old youth, 18-64 year old adults, and 65 years and older [8]. This thesis project recruited adults from the age of 18 years and older. Therefore, the following section will focus on the CPAG for 18-64 year old adults and 65 years and older.

The CPAG for the 18-64 year old adults and for the adults age 65 years and older have the same basic recommendations; however, the 65 years and older group have an additional recommendation to perform balance exercises to prevent falls by enhancing their mobility only if they present balance impairment [9-11]. The current CPAG recommendations are based on research that provides evidence that 150 minutes per week of MVPA of aerobic physical activity in 10 minute bouts or longer contributes to measureable health benefits [9, 10, 12, 13]. The CPAG also recommend that adults perform resistance training using major muscle groups for at least two days per week to add muscle and strength [11]. The CPAG provide several examples of moderate intensity activities, such as brisk walking, and vigorous intensity activities, such as cross-country skiing. Notably, people who meet the CPAG tend to have a lower risk of some chronic diseases, such as cardiovascular disease, colon and breast cancer, stroke and type-2 diabetes [12, 13]. The CPAG also provide suggestions to help people become more physically active in their community by suggesting that people join a community walking or running group. Therefore, the CPAG are evidence based and seek to translate the knowledge that researchers have gathered from their studies into public health messages that are easy for the general public to understand and implement. A copy of the CPAG for 18-64 year old adults is available for viewing within Appendix A and for 65 years and older within Appendix B.

Public awareness of the CPAG.

In Canada, less than 15% of adults reach the aerobic exercise recommendation in the CPAG by accumulating the recommended 150 minutes per week of MVPA in ten consecutive minutes to achieve health benefits [3]. A reason for this could be that Canadians are not aware of the CPAG and its recommendations. A recent study has evaluated Canadians knowledge of the CPAG and the results showed that 27% of Canadians were aware of the CPAG with only 16% knowing the specific recommendations [14]. Furthermore, only 62% of primary care professionals reported providing the CPAG to their diabetic patients as part of their physical activity counselling [15]. This statistic is surprising because the CPAG has been one of the most requested resources from the Public Health Agency of Canada [8, 16].

Negative health benefits of inactive behaviour.

Sedentary behaviour guidelines have been developed by CSEP to prevent inactivity in children and youth. The guidelines state that for health benefits, children and youth should minimize their recreational screen time (e.g., television, video games, computer) to less than two hours per day [17, 18]. In addition, children and youth should minimize the time they spend sitting, being indoors, and in motorized transportation (e.g., bus, car) [17, 18]. Currently, there are no sedentary behaviour guidelines for adults and older adults. However, CSEP is in the process of creating the sedentary behaviour guidelines for adults and older adults that would follow the similar concepts found in children and youth.

Inactive behaviour can cause negative health benefits, such as poor cardiorespiratory fitness and an increased risk for all-cause mortality [4-6] and reduced life expectancy [7]. It has been shown in scientific literature that a relationship exists between cardiorespiratory fitness and mortality [19, 20]. Cardiorespiratory fitness is an important prognostic factor for major cardiac events and all-cause mortality in healthy adults [19, 20]. For example, the relative risk of mortality was shown to be two times greater for people found in the least fit quintile compared to the next least fit quintile for cardiorespiratory fitness [19].

Furthermore, inactive behaviour has a negative effect on the overall health by increasing the risk of developing many chronic conditions, such as ischemic heart disease, diabetes, breast and colon cancer [2]. Specifically for older adults inactive behaviour can cause problems with balance and low muscle strength [21, 22] , which are both issues that increase the risk of falls and loss of autonomy [23]. In addition, it is known that adults who sit uninterrupted for 14 hours (sitting regime) have reduced insulin sensitivity and higher plasma lipid levels compared to adults who spent 8 hours sitting, 4 hours walking and 2 hours standing (i.e. a minimal intensity physical activity regime) [24]. Likewise, adults who perform one hour of daily vigorous physical activity and sit for 13 hours per day are known to have reduced insulin sensitivity and higher plasma lipid levels compared to adults in the minimal physical activity regime [24]. Therefore, the problem of high levels of inactive behaviour should be addressed by getting individuals more physically active and sitting less before the negative health benefits can play a role in their health.

Physical activity supports provided by primary health care.

Primary health care is defined as any type of service care provided by a health care professional in a clinic regarding the patient's health and promoting a healthy lifestyle [25]. Notably, primary health care may be a viable location to influence physical activity behaviour of inactive adults. In fact, there is evidence demonstrating that participants are more likely to change their behaviour if a physician tells them to change their behaviour [26]. About 70% of primary care professionals state that they discuss physical activity with their participants [4]. However, only 34% of patients reported discussing physical activity counselling with their primary care provider at their last primary care visit [27]. In

Manitoba, Hnatiuk et al. [28] conducted a study to evaluate the type of physical activity support health care providers deliver to patients and how patients perceive this support. Their data indicates that 83% of health care providers report that they asked the patient about their readiness to become more physically active, while only 46% of the patients reported that the health care provider did so. Additionally, 100% of the health care providers indicated that they talked about barriers that may prevent the patients from becoming more physically active; whereas, only 65% of the patients reported that they received this support. Furthermore, 87% of the healthcare providers stated that they discussed physical activity resources available within the patient's community and 54% reported that they referred the patient to a physical activity program offered in the community. In contrast, only 38% of the patients reported discussing physical activity resources in their community and 0% reported that their health care provider referred them to a physical activity program offered in the community [28]. This discrepancy may be explained by two different scenarios. The first scenario is that a majority of Canadians are not being advised to become more physically active by their physicians as often as physicians report. This is plausible because primary care providers often state limitations, such as lack of time [4, 29, 30] and lack of knowledge in counselling patients on physical activity [31, 32]. In addition, most primary care providers only provide physical activity advice for patients that have pre-existing conditions and require weight management [30, 33]. However, the second scenario is that primary care professionals are discussing physical activity with their participants, but that patients felt the physical activity prescription they received was insufficient [33] or language barriers made it difficult for the patients to understand the physical activity information being shared with them [34, 35].

Approaches used to enhance physical activity prescription in health care.

A study in New Zealand by Swinburn et al. [36] was conducted to evaluate the effectiveness of written advice from a general practitioner (Green Prescription) for increasing physical activity levels amongst previously inactive individuals, as compared to just verbal advice given from a general practitioner. About 450 participants received verbal advice about increasing physical activity from a general practitioner and then half were randomized to receive an additional written exercise prescription. Physical activity levels were then measured using a standard questionnaire that they created that showed good reliability for assessing physical activity. The questionnaire was completed at baseline during the first meeting with the general practitioners and at six weeks over a phone call follow-up with a trained interviewer. The general practitioners spent about five minutes to assess the participant's physical activity levels and provide advice to increase physical activity levels during the patient's appointment at baseline. About 80% of that advice given to both groups was about increasing their time spent walking. The results showed that overall in both groups the percentage of participants engaging in any kind of recreational physical activity increased. Notably, 17% of participants in the verbal advice group increased their activity levels; whereas, 32% of participants in the Green Prescription group increased their activity levels [36]. This study demonstrates how participants are more likely to make changes to their lifestyle if advised to do so by a physician [26]. It also demonstrates that health care is a viable location to provide exercise prescription for previously inactive adults.

What types of activity do people do when physically active?

In Canada, adults choose walking as the main mode of exercise (65%) followed by gardening (41%), and home exercise (24%) [37]. Furthermore, other favourite activities that Canadian adults like to do for exercise are biking (19%), swimming (18%), and social dancing (15%) [37]. This is surprising considering that less than 15% of people accumulate at least 150 minutes of MVPA on a weekly basis even though a majority of Canadians prefer to walk for exercise [3, 37]. In addition, only 35% of Canadian adults are accumulating the recommended 10,000 steps per day goal [3]. Specifically, Canadian men are accumulating 9,500 steps per day and Canadian women are accumulating 8,400 steps per day on average [3]. With this in mind, it is possible that even though people may be doing physical activity, they are not being physically active frequently enough or may not fully understand how to be active at moderate to vigorous intensities that would achieve measureable heath benefits.

Are people able to accumulate MVPA while walking?

A study conducted by Duncan et al. [38] investigated the effectiveness of walking at varied intensities and frequencies in a previously sedentary adult population aged 30-69 years. Their data indicates that sedentary adults, especially older adults can reach moderate intensity when walking [38]. In addition, Tudor-Locke et al. [39] compared clinical and free-living cadence in older adults (61-81 years). The results showed that older adults are capable of walking at cadences greater than 100 steps per minute [39]. A cadence between 95 and 110 steps per minute has been shown to be the minimum threshold for moderate intensity walking [40, 41].

A reason a majority of Canadians are not meeting the minutes of aerobic exercise to meet the CPAG could be because they do not know how to monitor walking at a moderate intensity. Therefore, Bouchard et al. [42] conducted a study to evaluate how effective three different methods to identify aerobic exercise intensity would be at helping inactive older adults reach the recommended minutes of aerobic exercise in the CPAG over 8 weeks. The participants were randomized into one of three groups using a specific method to monitor aerobic exercise intensity: heart rate (HR) monitor (% of maximum heart rate (HR_{max})), manual pulse (% of HR_{max}), or pedometer (walking cadence). The results indicated that none of the groups significantly increased their time spent performing MVPA or ability to identify exercise intensity correctly; however, the two groups using a device increased their total exercise time (both $p<0.01$) [42]. Specifically, the pedometer group showed a trend ($p=0.07$), where participants tended to more often correctly identify exercise intensity [42]. It is possible that the pedometer's ability to produce instant visual feedback enabled the user to recognize when they were walking at moderate intensity. Based on this data, it appears that pedometers can assist people to be aware of when they are performing MVPA, which might help them to reach the aerobic exercise component in the CPAG.

Methods to measure or identify physical activity intensity.

Doubly-labelled water

The technique referred to as the doubly-labelled water is used to evaluate free-living energy expenditure of an individual over a period of four to twenty-one days [43]. The doubly-labelled water method is very reliable and accurate at measuring energy expenditure with a relative accuracy of 1% and within subject precision of 5 to 8% [44]. The method involves the individual ingesting water with a known specific amount of stable isotopes of both oxygen (^{18}O) and hydrogen (^{2}H) that mix with the normal oxygen and hydrogen in the body within a few hours [43]. Then, as the individual expends energy throughout the day, the body produces carbon dioxide (CO_2) that is lost through breathing and water (H_2O) that is lost through breath, urine, sweat, and other evaporations [43]. In fact, ^{18}O is lost from the body more rapidly than ^{2}H because ^{18}O can be found in both CO_2 and H_2O, while ^{2}H is only found in H_2O [43]. The rate of CO_2 production is determined with difference between the elimination rates for both the isotopes and is used to calculate energy expenditure [43]. Furthermore, the doubly-labelled water method has been used as an objective criterion method to validate methods assessing dietary energy intake and physical activity [44-47].

The limitations to using the doubly-labelled water method include the isotopes being quite expensive [43, 48, 49]. However, a study by Mann et al. [49] showed that a reduced dose of doubly-labelled water positively correlates with resting energy expenditure measured by a metabolic cart ($r=0.87$, $p<0.01$). This means that more studies in the future may use the double-labelled water method with it being more affordable with the reduced dose and just as effective at measuring energy expenditure [49]. On the other hand, the technique still requires specific expertise to analyze the isotope concentrations in the samples [43, 48]. In addition, the doubly-labelled water method can only measure habitual energy expenditure over a certain time period making it difficult to obtain information about the brief periods of peak energy expenditure an individual performs during exercise [43]. Therefore, the doubly-labelled water technique would not be an ideal approach to use to measure exercise intensity.

Accelerometers

Physical activity intensity can be measured using different methods with some having the option of providing instant visual feedback. Accelerometers are accurate and reliable at objectively measuring [50, 51] the amount, intensity, pattern, and duration of physical activity that each individual completes in their free-living environment [52]. For example, accelerometer data can be analyzed to characterize different bouts of physical activity and different intensities, such as sedentary, light, moderate, and vigorous. The accelerometer can be used in a field setting, which makes it the optimal choice for measuring physical activity over a period of time. Accelerometers are about the size of a watch (4 cm x 4 cm) and are normally worn for a period of seven days [52]. The accelerometers are placed at the hip level, which allows the individual to perform their normal activities without interference. Accelerometers worn on the hip have been shown to have a moderate reliability of 0.66 to 0.78 for accuracy in measuring physical activity [53]. A limitation with using accelerometers for personal use is that they are quite expensive and require specific equipment to be analyzed. Also, specific skill and software is required to evaluate the data output. The accelerometer provides retrospective feedback because the information is obtained after a seven days period. This makes it difficult for participants to know if they are at the appropriate intensity while actually performing the exercise. Another problem is the bias of the participant doing more physical activity while they are wearing it. Finally, a limitation of accelerometers is that cut-points for classifying different intensities are arbitrary and based on population data rather than individualized for the specific person wearing the device. Even so, accelerometers are often used to assess changes in MVPA amongst diverse populations [3, 54-56].

Heart rate monitor

A heart rate monitor is a simple device that can be used to help identify when exercising at the appropriate intensity based on the target heart rate zones. To have visual feedback for the intensity target zones, an individual can wear a heart rate monitor. The review paper by Laukkanen and Virtanen [57] reported that heart rate monitors provide reliable and valid measures of heart rate at rest (HR_{rest}) and during exercise in adults and children. The heart rate monitor is moderately priced and is worn just below the chest and accurately identifies when a participant is working in their appropriate target zone based on HR_{max} [58].

There are two steps to calculating the target heart rate zone for moderate intensity exercise using the heart rate monitor. Step one is to determine an individual's HR_{max}, which can be measured directly using a graded exercise test or estimated using the age of the participant in *Equation 1 and Equation 2* [59].

$$HR_{max} = (220 - \text{age}) \qquad \textit{Equation 1}$$

$$HR_{max} = (220 - (0.7 \text{ X age})) \qquad \textit{Equation 2}$$

Equation 1 is the conventional HR_{max} formula and *Equation 2* is the Gellish et al. [60] theoretical HR_{max} formula [59]. Gellish et al. [60] developed their theoretical HR_{max} formula because the commonly used conventional HR_{max} formula was biased at measuring HR_{max}. They demonstrated that *Equation 1* overestimated HR_{max} in men and women under the age of 40 and underestimated HR_{max} in men and women over the age of 40 [60]. Therefore, *Equation 2* was developed to provide a more accurate estimate of HR_{max} [59, 60]. The direct measure for HR_{max} using the graded exercise test would be the most accurate choice to determine HR_{max} amongst both young and older adults. However, it involves using a treadmill or bike ergometer in a laboratory setting [61]. Therefore, it is not feasible to use in real world settings because it would be inconvenient for participants to come to a laboratory and exercise until exhaustion [61]. Also, this approach would be costly and time consuming to perform on a large population [61].

The last step is to calculate the target heart rate zone for moderate intensity exercise using the percentage of an individual's HR_{max} or Heart Rate Reserve (HRR). Moderate intensity exercise can be defined and prescribed as 55 to 69% of HR_{max} or 40 to 59% of HRR [62]. The HRR formula is shown as *Equation 3.*

$$HRR = (HR_{max} - HR_{rest}) \qquad \textit{Equation 3}$$

The Karvonen Formula Target Equation uses HRR to calculate the appropriate target heart rate zone for moderate intensity exercise. It is comprised of HR_{max} calculated using *Equation 1 and Equation 2*, HR_{rest} measured by the heart rate monitor, and the HRR formula [62]. The Karvonen Formula Target Equation is displayed in *Equation 4* [62].

$$\text{Target \% of HRR} = ((HRR) \times \text{Target Intensity \%}) - HR_{rest} \qquad \textit{Equation 4}$$

Once the exercising target zones are established, the individual can monitor their exercise intensity using a heart rate monitor [62].

The difficulty with heart rate monitors is that some confounding variables can affect heart rate reading. A study conducted by Dauncey and James [63] showed that confounding variables such as emotional stress and the type of activity being performed can influence heart rate without affecting oxygen uptake considerably. Also, heart rate monitors require some knowledge of how to operate the device properly and how to determine exercising target zones using *Equation 1, Equation 2, Equation 3, and Equation 4*, which could be an issue for some adults.

Self-perceived intensity

A simple method of assessing intensity during exercise is using self-reported intensity monitoring such as the talking test or self-perceived exertion scale (Ratings of Perceived Exertion, RPE) called the Borg Scale. The talking test is evaluated by an individual's ability to carry on a conversation during an exercise. If they notice a slight increase in their breathing while talking, it indicates that they are working at moderate intensity [64]. As for the self-perceived exertion scale, a score from 4 to 6 on a 10-point [65] or a score of 13 to 15 [66] on a 20-point scale would indicate moderate intensity. Dunbar and Kalinski [65] conducted a study using RPE to characterize exercise intensity of postmenopausal women during a 20-week exercise training program. The results showed that during training at week 2, the heart rate measured during the mean intensity of 40% of maximum oxygen consumption (VO_{2max}) did not differ from the target heart rate for that intensity based on RPE [65]. However, the study conducted by Whaley et al. [67] showed that there are differences between RPEs for different exercise protocols measured at 40%, 60%, and 80% of exercise intensity between genders. For example, men reported a higher RPE score than the women at the three exercise intensities [67]. In fact, the men reported RPE scores of 10, 13, and 16, while the women reported RPE scores of 8, 11, and 14 at the same three exercise intensities, respectively [67]. The difference between RPE scores reported by men and women is problematic because RPE scores are subjective measures and differ from person to person as each individual has their own experiences. Therefore, self-perceived intensity monitoring is not the best method to monitoring physical activity intensity because this variability.

Pedometers

Scientific literature has shown pedometers can significantly increase physical activity levels of previously inactive individuals [61, 68-71]. Additionally, pedometers are validated as a tool to estimate walking intensity using steps per minute to monitor physical activity [41]. In fact, pedometers provide instant visual feedback to monitor physical activity intensity. The pedometer is an inexpensive tool worn on the waist that is relatively easy to use and directly measures the number of steps taken during a specific time period. The person can divide the number of steps per period of time to estimate their cadence. However, activities such as swimming cannot be measured by the pedometer. Therefore, to compensate for activities that cannot be measured by the pedometer, such as swimming, it has been recommended that adding an extra 200 steps for every minute of that activity would be equivalent in terms of energy expenditure normally captured by a pedometer [72]. However, there is no such conversion for exercise intensity.

Research has shown that most people can reach moderate intensity when they are walking briskly at a pace of 100 steps per minute [39, 41]. However, 100 steps per minute may not be enough for physically active adults to reach moderate intensity because heart rate at any given intensity is lower in a physically fit individual compared to a less fit individual [73]. Therefore, a method to individualize the cadence-based prescription may be an optimal strategy to help individuals to achieve moderate intensity during exercise.

Instant feedback versus retrospective feedback

Accelerometers provide retrospective feedback, which makes it difficult for individuals to evaluate exercise intensity while they are performing the activity. In fact, research has shown that instant visual feedback from a heart rate monitor or pedometer [42, 74] is more effective than retrospective feedback from an accelerometer for promoting adherence to an exercise program [75]. In the Nemoto et al. [75] study, participants were randomly assigned to a no walking training group (control) (n=84), moderate-intensity continuous walking training group (n=75), or a high-intensity interval walking training group (n=87) for five months. The moderate-intensity continuous walking training group monitored their physical activity with a pedometer, while the high-intensity interval walking training group monitored their physical activity with an accelerometer. After the 5 months of training, a survey was completed to see which participants in each group met the training criteria given to them at the beginning of the study. The results showed that the proportion of participants that met the training criteria was 55% in the no walking group, 68% in the moderate-intensity continuous walking training group and 48% in the high-intensity interval walking training group [75]. The limitation is that the percentages of participants meeting the training criteria may be due to the training intensity rather than the devices. Despite the limitation, using a pedometer to monitor physical activity may be the best tool to help participants adopt a more physically active lifestyle given that it provides immediate visual feedback is relatively inexpensive and requires only basic knowledge of electronic equipment to utilize.

Are total step-based goals effective for increasing physical activity amongst previously inactive adults?

Bravata et al. [68] conducted a systematic review to evaluate the association between the use of pedometers and physical activity levels and health outcomes in outpatient adults. Studies were included if they reported pedometer use among more than 5 outpatient adults and data indicating a change in steps taken per day. Twenty-six studies (18 randomized controlled trail [RCT] and 8 observational studies) that included a total of 2767 participants met the inclusion criteria out of 2246 citations found in the search. A majority of the participants were women at 85% with a mean (standard deviation; SD) age of 49 (9) years. The mean intervention timeline was 18 weeks. In the RCTs, intervention participants increased their physical activity by 2491 steps per day more than the control participants (95% confidence interval [CI], 1098-3885 steps per day, $p<0.001$). In the observational studies, participants that used a pedometer increased their physical activity by 2183 steps per day, as compared to baseline (95% CI, 1571-2796 steps per day, $p<0.0001$). Overall, those participants who used a pedometer increased their physical activity by about 27% when compared to baseline. Furthermore, having a step based goal was shown to be a significant predictor of increased physical activity ($p<0.001$) [68]. This systematic review provides evidence to support the notion that total step-based goals monitored using a pedometer can effectively increase physical activity in outpatient adults. However, it cannot be determined whether this increase in physical activity can be maintained long term. Additionally, it is not clear if physical activities were performed at moderate-to-vigorous intensities.

Baker et al. [76] conducted a randomized controlled trial to evaluate the effectiveness of a 12 week community-based pedometer walking intervention “Walking for Wellbeing in the West” aiming to increase daily step-counts, self-reported physical activity and health outcomes in an inactive Scottish population (aged 18-65). Seventy-nine participants were randomized to either a control group or an intervention group. The participants in the control group were asked to maintain their current physical activity levels from baseline to week 12. The intervention group received a physical activity counseling session and a

12 week pedometer-based walking program focused around total daily step-based goals. The total daily step-based goals were structured so that by week six the participants would be achieving 3,000 steps above their baseline steps on at least five days per week. After week six, they would maintain the total daily step goal of 3,000 steps above their baseline steps on five days per week for the remaining six weeks. Outcome measures were evaluated at baseline and 12 weeks. The results showed that the control group showed no significant difference between steps per day at baseline (6924 ± 3201 steps/day) and week 12 (7078 ± 2911 steps/day), while the intervention group had a significant increase from steps per day at baseline (6802 ± 3212 steps/day) and week 12 (9977 ± 4669 steps/day). A chi-square analysis showed that there was a significant greater percentage of participants achieving 15,000 steps per week with 64% in the intervention group compared to 10% in the control group. Self-reported data showed that there were significant increases in the intervention group in time spent in leisure walking (+100 minutes per week) and significant decreases in time spent sitting on the weekdays (-1200 minutes per week), weekends (-360 minutes per week), and in total (-1680 minutes per week); whereas, no changes occurred in the control group from baseline to week 12 [76]. These results demonstrate that total step-based goals monitored by a pedometer can effectively increase the total daily physical activity levels of inactive participants over a 12-week period. However, these results do not indicate whether or not the enhancements in physical activity were maintained after the 12 week pedometer intervention. Moreover, MVPA was not measured making it difficult to evaluate if participants were reaching the aerobic exercise recommendation from the CPAG.

Fitzsimons et al. [77] followed up the "Walking for Wellbeing in the West" intervention study by Baker et al. [76] by conducting another study to determine the same outcomes over a longer 12-month follow-up period. The first objective was to identify the longitudinal effects of a 12-week pedometer-based walking program on physical activity behaviour and health outcomes over a 12 month period. The second objective was to find out if the addition of a physical activity counseling session would enhance physical activity and health outcomes to a greater extent over the 12-month period, as compared those who do not receive physical activity counseling. This study used the same design, groups (control and intervention) and 12-week pedometer-based walking program from the Baker et al. [76] study. The control group was placed on a 12 week waiting list before receiving the 12 week pedometer-based walking program with minimal physical activity advice and no physical activity counseling sessions over the 12 month trial; whereas, while the intervention group received the 12 week pedometer-based walking program immediately, in addition to four physical activity counseling sessions over 12 months. Outcome measures were evaluated at pre-intervention and at 12 weeks and 24 weeks, and 48 weeks after receiving the intervention. The results showed that there was no significant difference between the two groups for healthy outcomes and steps per day. Both groups showed a significant enhancement for mood status, and quality of life and a significant increase in step counts over time. The average increase in steps per day for both groups combined at baseline, 12 weeks, 24 weeks, and 48 weeks were 6941 steps/day, 9237 steps/day, 8804 steps/day, and 8450 steps/day, respectively. Based on this data, it appears that a pedometer intervention can promote a more physically active lifestyle over a 12 month period. Additionally, although physical activity counseling did not have further influence on the number of steps taken daily above what was observed with the pedometer alone, the intervention group reduced their sedentary behaviour by -451 ± 848 minutes, whereas, the control group had a smaller reduction of -130 ± 568 minutes for weekly sedentary behaviour, respectively [77]. In addition, both groups showed significant improvements for mood and quality of life over the 12 month study. Based on that data, it seems important that step-based pedometer interventions should include physical activity counseling sessions to change an individual's behaviour to help them adopt a healthier lifestyle, including more physical activity and less sedentary behaviour.

The Green Prescription intervention enhanced with a pedometer.

Kolt et al. [78] took the Green Prescription Intervention to the next level by adding a pedometer and a specific step goal target as a strategy to increase the physical activity levels of inactive older adults. Additionally, the effects of the interventions on blood pressure, body mass index (BMI), functional status, and health-related quality of life were assessed. About 330 low-active older adults were recruited from 10 primary care sites in New Zealand and were randomized to either the Standard Green Prescription Group or the Pedometer Step-Based Green Prescription group. Both groups had an in person visit with their physician and three physical activity counselling sessions over the phone over 12 weeks to increase their physical activity levels. The Standard Green Prescription group received counselling that focused on accumulating physical activity using time-related goals, while the Pedometer Step-Based Green Prescription group received counselling that focused on total daily steps target goal prescribed using a pedometer. Outcomes consisted of the Auckland Heart Study Physical Activity

Questionnaire, blood pressure, BMI, 36-item Short Form Health Survey (quality of life), Short Physical Performance Battery (physical function status), and self-reported falls or injuries. Data was collected at baseline and then again at 12, 16, and 52 weeks. The data indicated that both groups increased their physical activity levels and reduced their blood pressure following the 12-week intervention and these effects were maintained after 52 weeks. More notably, the Pedometer Step-Based Green Prescription group increased their leisure walking time by 63 minutes per week, as compared to 31 minutes per week for the Standard Green Prescription group after 12 weeks. After 52 weeks, the Pedometer Step-Based Green Prescription group was able to maintain their increased leisure walking time from the 12 week follow-up (+50 minutes/week) to a greater extent, than the Standard Green Prescription group (+28 minutes/week) after 52 weeks [78]. Therefore, it appears that a pedometer step-based exercise prescription can be a viable approach to increase physical activity amongst inactive adults. However, there was a limitation with exercise intensity not being measured because it could not be determined if individuals were meeting the aerobic exercise component in the CPAG by walking.

Heron et al. [79] conducted a study examining the effect that two pedometer interventions using different step-based goals have on patients ages 35-75 attending four primary care clinics that completed a General Practice physical activity questionnaire during their appointments over 12 weeks. Forty-one patients were classified by the questionnaire as "inactive" and completed baseline assessments before being randomly assigned to either group 1 (prescribed a self-determined goal – non specific increase) or group 2 (prescribed a specific goal – 2500 steps/day above baseline). Both groups were required to keep step-count activity logs and received telephone follow-up calls at 1, 2, 6, and 11 weeks. The results showed that mean baseline step counts were similar between group 1 (5685 steps/day, SD 2945) and group 2 (6513 steps/day, SD 3350). In fact, group 1 (2602 steps/day, SD 1957) showed a greater mean increase in steps/day compared to group 2 (748 steps/day, SD 1997) (p=0.005) [79]. These results support pedometer step-based exercise prescription as an effective method to increase total physical activity levels of inactive individuals from primary care clinics. However, exercise intensity was not measured in this study making it difficult to determine whether or not these individuals were walking at a moderate or vigorous intensity in order to meet the aerobic exercise component of the CPAG.

Can pedometers help people increase MVPA while walking?

A study conducted by Marshall et al. [41] was designed to translate the physical activity recommendations of at least 150 minutes of MVPA into a pedometer-based step goal. To accomplish this, the research team recruited 97 adults from the community to complete four 6-minute incremental walking bouts on a treadmill at different speeds, while measuring oxygen consumption using a metabolic cart. Three Metabolic Equivalents (METs) was determined as the threshold for moderate intensity based on the oxygen consumption of the participants [41]. The three METS threshold for moderate intensity that Marshall et al. [41] used would be considered as low-intensity aerobic exercise if it was following the recommended guidelines outlined by Warburton et al. [62]. The cadence was measured when three METs were achieved [41]. They found that the different step rates analyzed showed a minimum threshold for moderate intensity walking being between 100 and 110 steps per minute [41]. Therefore, to reach the recommendation of at least 150 minutes of moderate to vigorous intensity physical activity a week, a person should do a minimum of 15, 000 steps per week split amongst bouts lasting 10 minutes or longer on 5 or more days per week to reach the aerobic component of the CPAG [41].

Marshall et al. [56] followed up their 2009 study by evaluating how effective three different pedometer-based step goals were for increasing MVPA in 180 healthy Latina women (aged 18-65). Women were recruited from 12 sites in San Diego and randomized into one of three interventions. Each intervention provided a 12 week theory-based physical activity intervention with weekly meetings for goal setting, but the groups differed in the prescription of step targets. Specifically, the first group used self-selected goals (SELF), the second group used 10,000 steps per day goal (FREQUENCY), and the third group used 3000 steps in 30 minutes goal (CADENCE). Physical activity levels were then measured using accelerometers at baseline and 12 weeks after the interventions were completed. Notably, the results showed that there was no significant difference between levels of MVPA measured in SELF, FREQUENCY, or CADENCE after 12 weeks. Even so, participants in the CADENCE based intervention were more likely to accumulate MVPA in 10 minute bouts or longer (~1.25 bouts per day - median), as compared to SELF (0.2 bouts per day - median) or FREQUENCY (0 bouts per day - median) [56]. From these results, we can speculate that the CADENCE based prescription may be a strategy that enables participants to increase the amount of MVPA they perform on a weekly basis.

Integrating an exercise specialist into the primary health care team.

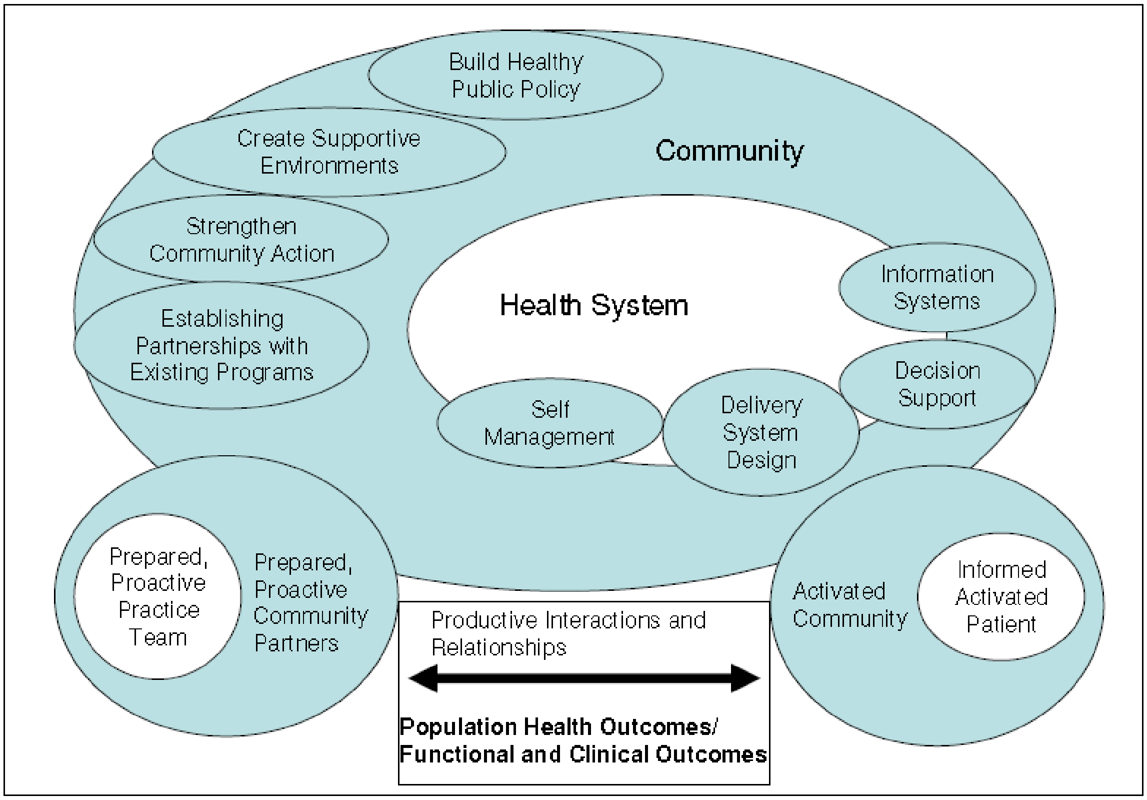
The addition of exercise specialists to the primary health care team is another strategy to address the limitations primary care providers' report, such as lack of time [29, 30] and experience [32] in counselling patients on physical activity [80, 81]. This approach is supported by the United States Department of Health and Services because there is evidence indicating that exercise specialists can help participants become more physically active [4, 82]. In Canada, CSEP has a Certified Exercise Physiology (CEP) training program, which provides the appropriate knowledge and skills to prescribe exercise for healthy populations and populations characterized by chronic conditions. CSEP-CEP's are also able to conduct health related fitness assessments in order to design individualized exercise prescriptions to safely increase the physical activity of participants of all ages, whether they have chronic diseases or not, if they are medically cleared by a physician to participate to a physical activity program [83]. Specifically, they are able to conduct both maximal and submaximal assessment protocols to evaluate physical fitness. However, they are not authorized to work with acutely injured participants and individuals that are not cleared by their physician to participate in physical activity. Also, CSEP-CEPs cannot diagnose any pathology based on the evaluation of the assessments they conduct with the participant. Nonetheless, the CSEP-CEP certification is preferred over other exercise certifications in Canada because a 4-year university degree in exercise science or related area is required prior to passing a standardized written and practical test. Additionally, 200 hours of applied experience working with clinical populations is required for a candidate to become certified [83]. The CSEP-CEP scope of practice and competencies are available for review in Appendix C.

In Canada, a study was conducted by Fortier et al. [55] to evaluate the impact of integrating a physical activity counsellor in the primary health care team would have on a population of previously inactive adults at a community-based primary care clinic. The participants in that study received brief counselling about physical activity from their provider at baseline and were randomized either to a control group or an intervention group. The control group received no further counselling about physical activity, while the intervention group received six intensive physical activity counselling sessions over the next 12 weeks from a physical activity counsellor. The physical activity counsellor had a Bachelor's of Science in Human Kinetics and was a CSEP-Certified Fitness Consultant (CFC), which was the certification program that preceded the development of the CSEP-CEP credential and was the highest qualification at the time in Canada. Physical activity outcomes were measured using questionnaires and accelerometers and were evaluated at baseline and then again every six weeks. The follow-up period after the completion of the 12 week intervention consisted of data being obtained at 13, 19, and 25 weeks. The results showed that at 6 and 13 weeks, the intervention group significantly increased their self-reported physical activity levels by about 8 units, as compared to the control group. The increase of 8 units in self-reported physical activity is equivalent to performing two additional 20 minute exercise sessions a week with one session being done at a mild intensity (i.e. 3 units) and the other at a moderate intensity (i.e. 5 units). However, there was no significant difference between the groups in terms of self-reported physical activity during the follow-up period. Additionally, there was no significant difference between the two groups when physical activity levels were measured by accelerometers at any time point [55]. Therefore, it appears that general physical activity counselling may not be the solution to increasing physical activity levels of inactive people. In fact, the data suggests that alternative strategies are needed to help people become more physically active. For example, it is possible that physical activity counselling would be more effective if the CSEP-CEP were to recommend that the client utilize the immediate visual feedback from a pedometer to monitor their physical activity levels.

The ENCOURAGE Project.

Our research group developed a study to better support physical activity as a health intervention through physical activity counselling and referrals to community-based physical activity opportunities in inactive adults. The purpose of the ENCOURAGE project (ENhancing primary care COUnselling and Referrals to community-based physical Activity opportunities for sustained lifestyle chanGE) was to improve physical activity prescription within two primary health care clinics and to develop a referral process to link patients from the clinic to community-based physical activity programs or self-directed physical activity opportunities. One hundred and nineteen eligible participants were recruited from two primary care clinics in Winnipeg, Manitoba to participate in the ENCOURAGE project. Eligible participants were identified after using a touch screen computer *Risk Factor Identification Tool (RFIT).* This tool enabled the research team to assess the participant health risks and readiness to change their behaviour by asking the participant questions about their relevant risk factors for chronic disease. From the participant answers, a report was printed containing information about chronic risk disease factors that the participant could choose to show to their primary care provider. The *RFIT* was developed and validated by our research team [84]. The questions that are asked during the RFIT can be found in Appendix D. The ENCOURAGE study participants received five physical activity counselling meetings over a 16-week period with a CSEP-CEP, with each lasting approximately 30-60 minutes in length. The outcomes were measured using a series of questionnaires assessing different variables, RFIT, and accelerometer data taken at five times points (Baseline, 8, 16, 24, and 40 weeks) to assess participant's physical activity levels over time. The ENCOURAGE project differed from the Fortier et al. [55] study because it was conducted at multiple primary clinic sites, had a longer intervention period and a longer follow-up period. It also utilized the Expanded Chronic Care Model (Figure 1) to guide the development of specific aspects of the project [85].

Figure 1: The Expanded Chronic Care Model. The ENCOURAGE project combined the work health systems provide and community participation to promote population health that targets chronic disease issues. *Adapted from Barr et al. Hosp Q. 7:73-82. 2003* [85].



The components of the Expanded Chronic Care Model that the ENCOURAGE project influenced are:

1) Delivery System Design – The study created a referral system for participants to be referred from health care professionals at the clinics to a CSEP-CEP. The CSEP-CEP was then able to refer the participants to physical activity programs in the community.

2) Decision Support – The addition of the CSEP-CEP to the health care team ensured that participants could receive specific physical activity counselling to

become more active and gain health benefits. The CSEP-CEP also supported the health care professionals at the health care clinics by providing them with specific physical activity supports or referral information for their patients. The RFIT also supported decision making by providing a report about chronic disease risk factors, which the physician could use to decide if a referral to a specialist was needed to provide optimal care to the patient [84].

3) Information Systems – The Electronic Medical Records (EMR) was the information system utilized, where all health care professionals at the two clinic sites can enter patient information to be reviewed by each other. Notably, other health care professionals were able to read the physical activity notes entered in the EMR by the CSEP-CEP during participant meetings to follow patients as they tried to become more active. They reinforced the physical activity behaviour change by speaking with the patient. Finally, they documented their notes within the EMR so the CSEP-CEP could continue to build on their input. This innovation allowed for discussion between health care professionals as they could work together to reinforce health behaviour change.

4) Self-Management – The CSEP-CEP taught the participants the skills they needed to develop their own action plans to become physically active and provided them with the skills and tools needed to address current and future barriers that may have prevented them from being more physically active.

5) Establishing Partnerships with Existing Community-Based Physical Activity Programs – The CSEP-CEP developed partnerships with existing community-based physical activity programs, such as the Young Men's and Young Women's

Christian Association of Winnipeg Incorporated (the YMCA-YWCA). This established a referral process between the CSEP-CEP and nearby exercise facilities to provide the participants with more options to become more physically active with different physical activity programs. For example, the CSEP-CEP established a program where facilities provided participants with free tours and day-passes to experience first-hand the facility based on the recommendations from the CSEP-CEP. The CSEP-CEP also referred patients to exercise classes at these facilities as a way to match participant interests with existing programs. This could have appealed to the participants more and motivated them to become physically active at the existing program.

6) Create Supportive Environments – The ENCOURAGE project research team helped existing service providers develop new exercise classes in various locations in Winnipeg, such as the public library, City of Winnipeg facilities and Access health clinics, where participants could exercise in a comfortable environment and develop relationships with other participants. The exercise classes were specifically designed to help create a link between the primary health care clinic and the community to be able to refer patients to community exercise programs tailored for previously inactive adults. This approach helped the participants feel more comfortable being physically active because the exercise classes were appropriate for the patient's physical activity level.

7) Strengthen Educational Programs Offered at the Clinics – The primary health care clinics run programs that provide knowledge about coping with certain chronic diseases, such as Type 2 Diabetes. These programs are led by different

specialists depending on the topic being covered. For examples, nutritional information has traditional been taught by a Dietician. In contrast, physical activity was not being taught by an exercise specialist. The ENCOURAGE project addressed that limitation so physical activity information was being taught by the CSEP-CEP at the two clinic sites.

Community-based interventions following a social ecological framework have been shown to positively influence PA behaviour and attitudes [86, 87]. Ecological models are used in public health to assess people's interactions with their physical and sociocultural surroundings [88]. The ENCOURAGE project incorporated specific aspects from two domains in the ecological model framework for active living [87]. The two domains were active recreation and active transport [87]. Active recreation was addressed in the ENCOURAGE project with the referral system linking the individual to community organizations, such as the YMCA-YWCA that provide programs and opportunities to take part in physical activity. Active transport was utilized in the ENCOURAGE project with the CSEP-CEP promoting active transport as a way to increase physical activity levels since most people choose to walk as their main mode of exercise [37].

The ENCOURAGE project provided the link needed between the health care system and community-based programs to help inactive adults become more physically active by offering physically activity counselling from a CSEP-CEP and a referral system to physical activity programs in the community. It is notable that walking was an activity that 46 of 119 participants in the ENCOURAGE project identified as their preferred way to enhance their activity levels. In fact, the CSEP-CEP taught the study participants' how to utilize a pedometer as a tool to increase their physical activity levels by monitoring the total number of steps they take in a day. However, he did not typically teach participants how to use pedometers as a tool to help them understand how fast they should walk in order to achieve better health outcomes or reach the intensity recommended by the CPAG for aerobic exercise. With this in mind, our research team considered the merits of embedding a second research study within the ENCOURAGE project to specifically determine if teaching patients how to use a pedometer to monitor their exercise intensity, while walking, would increase the total time spent at MVPA. Such an approach has been used previously by Kolt et al. [78], where a pedometer-based exercise prescription was embedded into the ongoing Green Prescription physical activity intervention to determine if this additional strategy would enhance physical activity levels to a greater extent.

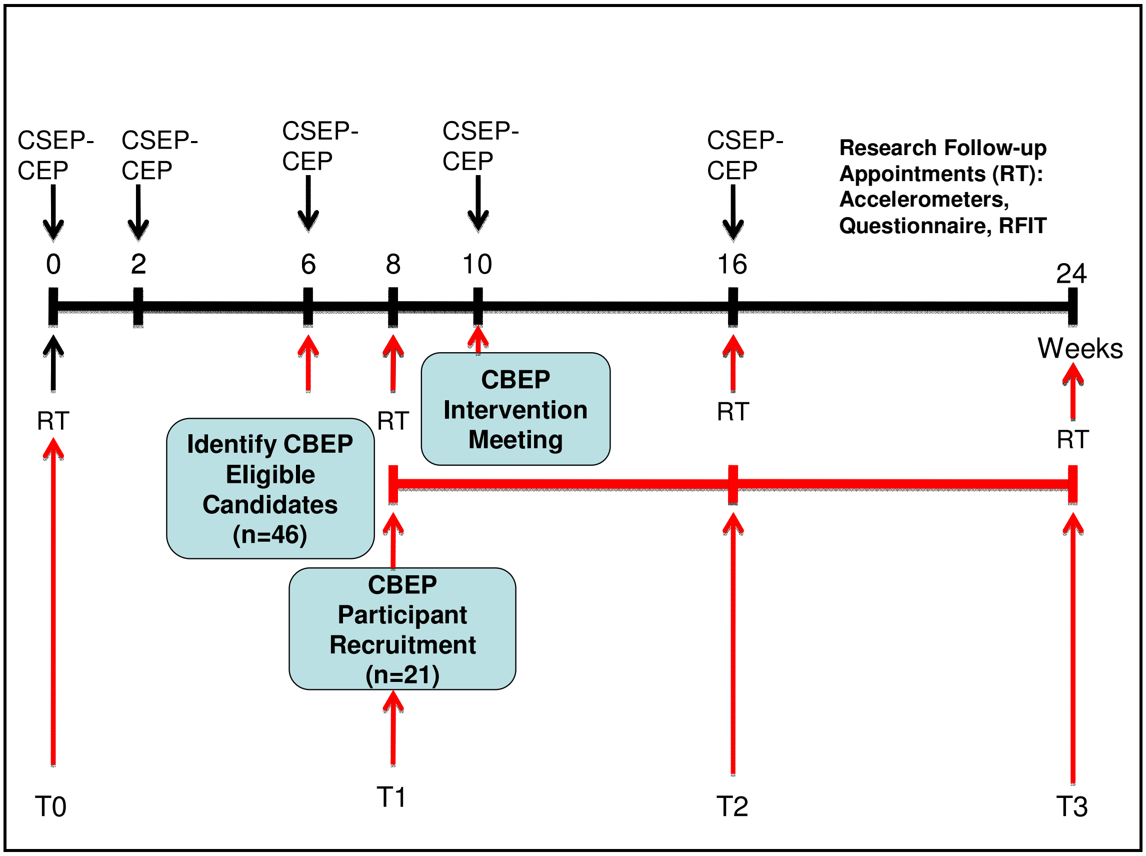
Chapter 2: Study Design

Rationale, objectives and hypotheses

A majority of Canadian adults are not reaching the appropriate volume and intensity of physical activity required to reach the aerobic exercise recommendation in the CPAG. Based on the literature presented, adults have a difficulty recognizing their exercise intensity and, therefore have difficulty doing 150 minutes of MVPA. However, we believed that there was an opportunity to help previously inactive adults to increase the time spent at MVPA during walking by providing them with instant visual pedometer feedback and a specific cadenced-based exercise prescription so they can recognize, monitor and understand when they are exercising at a moderate-vigorous intensity.

The objective of this *prospective interventional trial* was to determine if an individualized cadence-based pedometer exercise prescription increases the amount of time that participants spend doing moderate-vigorous intensity while walking. The individualized cadence-based pedometer prescription was generated during an intervention meeting that consisted of a combination of an indirect aerobic fitness test, a short educational session and the use of a pedometer to individualize the walking cadence (steps per minute) needed to reach moderate intensity for each participant. After the meeting, the participants were instructed to use their individualized cadenced-based exercise prescription to monitor their intensity when exercising on their own. The primary outcome measure was a change in the total number of weekly minutes spent exercising at moderate-vigorous intensity, as measured by accelerometer before and after the intervention meeting. We collected data at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as seen in Figure 2. Furthermore, we determined if the amount of MVPA was enhanced to a greater extent amongst participants who received the individualized cadence-based prescription, as compared to those who do not.

Figure 2: The prospective interventional trial design that was utilized for participant recruitment and data collection for the Pedometer Project. *CSEP-CEP*, Canadian Society of Exercise Physiologists – Certified Exercise Physiologist; CBEP, Cadence-Based Exercise Prescription; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point.



We hypothesized that:

1) The group of people who received the individualized cadence-based pedometer exercise prescription (CBEP) would increase their MVPA time to a greater extent compared to the standard care group (SC) at T2 and T3, as compared to T1.

2) CBEP will improve other objectively measured physical activity and self-reported outcomes to a greater extent compared to SC at T2 and T3, as compared to T1.

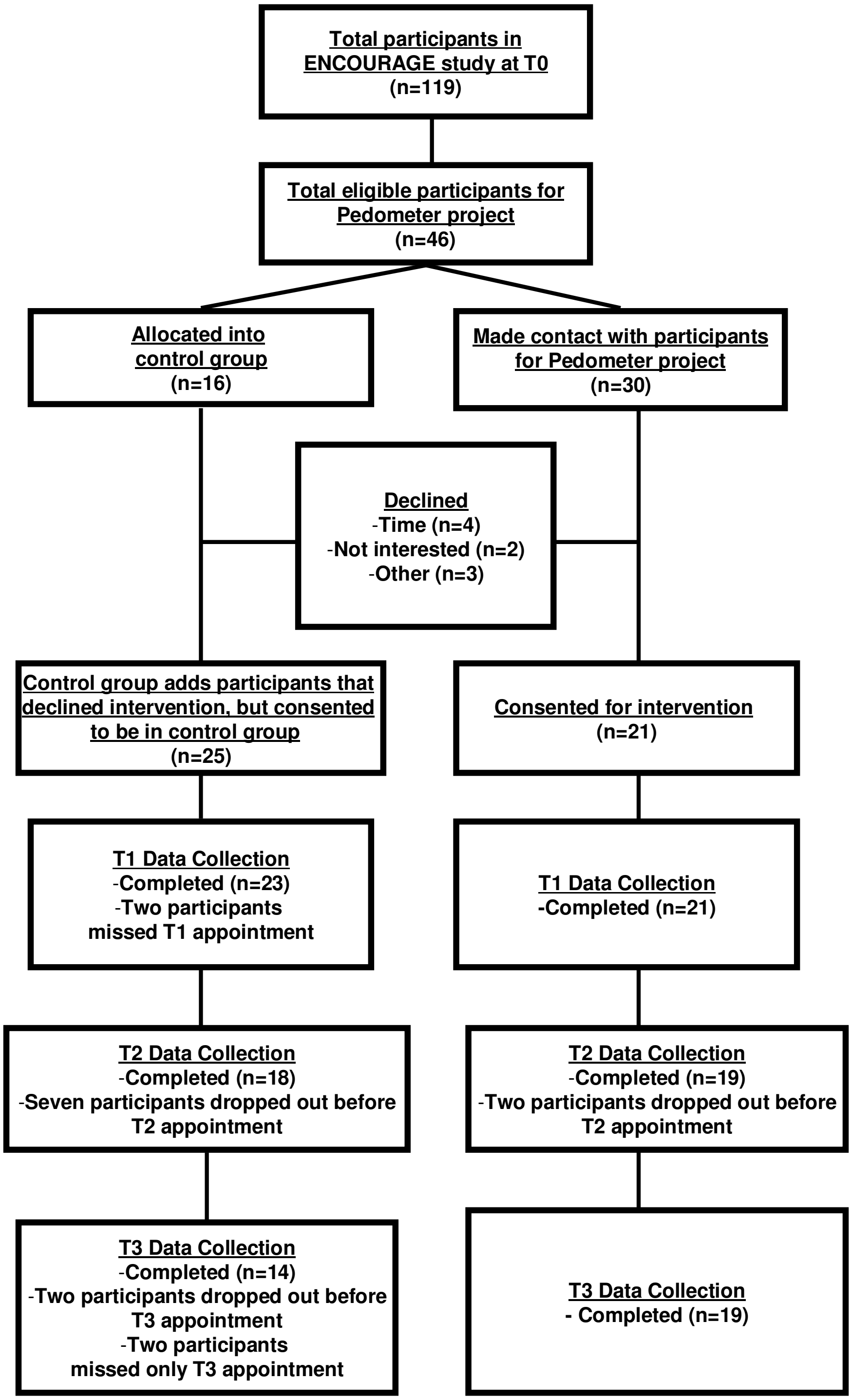
Ethics approval

The study has been approved by three ethics review panels, namely 1) the University of Manitoba Education/Nursing Research Ethics Board (ENREB); 2) the Winnipeg Regional Health Authority Research Review Board; and 3) the St. Boniface Hospital Research Review Committee.

Participant recruitment

For clarity, we will refer to the current study as the Pedometer project to distinguish it from the ENCOURAGE study. The participants for the Pedometer project were recruited from the ENCOURAGE study cohort. One reason for using this approach is based on opportunity because one of the tools that the ENCOURAGE CSEP-CEP used to support patients as they sought to increase their physical activity levels was to provide some of them with a pedometer and advise them to achieve the 10,000 steps per day. However, his standard practice was to prescribe a total steps based prescription. With this in mind, there was an opportunity to recruit a total of 46 participants that were eligible for the pedometer project. See Figure 2 for the flow of recruitment.

Figure 3: The total number of participants involved in each section of the recruitment process for the Pedometer project. To, baseline time point, T1, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point.



The inclusion criteria for the ENCOURAGE study consisted of male and female participants in the age range of 25 to 75 years that are identified as physically inactive by the RFIT (i.e. they self-report not meeting the CPAG recommended aerobic exercise of 150 minutes of moderate-vigorous intensity physical activity weekly) and reported being ready to adopt a more physically active lifestyle (i.e. they self-report being in the preparation stage of behavioural change as described in the transtheoretical model [89]). Participants were excluded from the ENCOURAGE study if they had previously been diagnosed with a chronic disease (such as type 2 diabetes) or other conditions that would limit their ability to complete the intervention, such as exercise-induced angina or arrhythmia. Participants were also excluded if they were in the pre-contemplative stage of change because these participants are less likely to adopt a more physically active lifestyle [89].

It is important to indicate that the current pedometer study had additional inclusion criteria. For example, participants must report that walking was their main mode of physical activity. Also, participants must have been using a pedometer so they are familiar with how to use the device and its functions. A person was excluded from the study if they could not participate due to physical limitations (e.g., shin splints, deep vein thrombosis, leg injury) that would prevent them from being able to walk. People that could not attend the cadence-prescription meeting for any reason, such as geographical limitations, were also excluded. Finally, participants that were using medications that limited heart rate were excluded. This criteria was selected because heart rate was utilized to help calculate the individualized cadence-based prescription.

The 46 eligible participants that were eligible for the pedometer project were allocated to either a Standard Care group (SC; n=25) or Cadence-Based Exercise Prescription group (CBEP; n=21). The specific processes for participant recruitment and data collection that were utilized in the Pedometer project are summarized in Figure 3. Specifically, the processes that were utilized include:

1) Participants were identified for inclusion in this study by the CSEP-CEP involved in the ENCOURAGE study after they met with the CSEP-CEP on three occasions during the first six weeks of the ENCOURAGE study. The CSEP-CEP then forwarded the names of the potential participants to the Pedometer project research staff. A recruiting list for potential participants was developed in order of the date for their scheduled eight week follow-up appointment as part of the ENCOURAGE study.

2) The research staff were aware that there was potentially bias with the CSEP-CEP identifying and influencing potential participants for the Pedometer project. Therefore, a number assignment of 2:1 for participants being approached for the Pedometer project was used for allocation. The number system consisted of the research staff approaching the two eligible participants on the eligibility list at their scheduled eight week follow-up appointment as part of the ENCOURAGE study. This was when the research staff would introduce the Pedometer project to determine if the participant was interested in joining the CBEP intervention. If the approached participant did not want to participate in the CBEP intervention then they were asked if they would be willing to be part of the SC group. The third eligible participant on the recruiting list was automatically placed in SC. The

number system was repeated and followed no matter what the first two eligible participants approached decided to do.

3) If they volunteered to participate in the Pedometer project, they were asked to provide informed consent. The SC group was asked to complete the series of questionnaires, RFIT and wear an accelerometer for a 7-day period. While the participants assigned to the CBEP group completed the same standard care as the ENCOURAGE project cohort, they received a pedometer intervention sheet with instructions regarding the intervention meeting scheduled within the following two weeks. The Pedometer intervention sheet can be found in Appendix E.

4) T0 for the ENCOURAGE study was used as a reference point to compare to the T1 data collection for the Pedometer project (Figure 3). Follow-up data was then collected at T2 and T3 based on the ENCOURAGE study data collection schedule.

Standard care

The 25 participants in the SC group continued to receive standard care as part of the ENCOURAGE study as summarized on Table 1. Briefly, standard care consisted of five 30-60 minute meetings (i.e. baseline, 2 weeks, 6 weeks, 10 weeks, and 16 weeks) designed to help the participant learn the skills they need to develop an action plan so they can become more physically active.

Table 1: The CSEP-CEP followed the time line session guide to provide the standard care to all participants in the ENCOURAGE study.

# Months	Type of meeting	Purpose	Suggested tools
baseline (1st session with the CSEP-CEP)	In person (60 min) **Focus on relationship and gathering information**	Stages of change Values life and how exercise fits in Benefits of exercise Education about PA recommendations Barriers Activity preferences Short-term and long-term goals (SMART) Information about the resources in the community How to use the pedometer and the log sheet Action plan (first-step planner or self-contract) for the first 2 weeks	Stages of changes questionnaire, Decision balance sheet, Goal setting worksheet, Choosing alternatives for action, Activity Inventory, Self-efficacy questionnaire, Pedometer, Daily activity log and pedometer resource sheet, First-step planner and, Self-contract, Dose Response
2 Weeks (2nd session with the CSEP-CEP)	In person (30 min) **Focus on social support**	Review the previous goal Positive feed-back (compare to baseline) Involvement in existing community programs Rewards & Motivation Social support Pedometer counts Action plan (first-step planner or self-contract)for the next 4 weeks	Relapse planner Social support cues?
6 Weeks (3rd session with the CSEP-CEP)	In person (30 min) **Focus on progress and observed changes**	Review the previous goal Positive feed-back (compare to baseline) Review the progress done so far Restating the values Involvement in existing community programs Pedometer counts Action plan (focus on 1 goal) for the next 4 weeks	Relapse planner
10 Weeks (4th session with the CSEP-CEP)	Phone call (20 min) **Focus on enjoying exercise**	Review the previous goal Positive feed-back (compare to baseline) Assess barriers and motivation Involvement in existing community programs Pedometer counts Action plan (focus on 1 goal) for the next 6 weeks	Relapse planner
16 Weeks (5th session with the CSEP-CEP)	In person (45 min) **Focus on seeing them as an exerciser**	Review the progress done through the program Positive feed-back (compare to baseline) Review the previous goal and establish a establish long-term goal What to do if they lose motivation? Tips to stay active Pedometer counts Setup a long-term challenge Apply what they have learn with the take home sheet	Relapse planner Take home sheet

CSEP-CEP, Canadian Society of Exercise Physiologists – Certified Exercise Physiologist.

Cadence-based pedometer exercise prescription group

In addition to the standard ENCOURAGE intervention, the 21 participants in the CBEP group met with the Pedometer project research team for a 60 minute meeting at the participant's preferred location where it was possible to walk for 30 consecutive minutes on a flat surface (e.g., mall, arena, park, walking trail, sidewalk near their home or at a fitness gym on a treadmill). During the meeting, the participant received 10 minutes of instructions on how to walk at a speed that was considered to be a minimum of moderate intensity (40%-59% of HRR) and its importance for optimal health benefits [62]. The participant was asked to wear a Garmin FR60 heart rate monitor that included accessories such as a foot pod to measure cadence (steps/min), a watch to display the participant's heart rate and cadence (steps/min) and a chest strap [90, 91]. While receiving the instructions, the participant was in a seated position for a minimum of five minutes. This approach was utilized so we could measure HR_{rest}. We then used *Equation 2, Equation 3, and Equation 4* (*n.b.; found in the Heart Rate Monitor section of the document*) to calculate the participant's heart rate target to achieve the walking cadence equivalent to moderate intensity. For *Equation 4,* we used 50% of HRR as the target intensity because it is the middle point of the target heart rate zone considered moderate (40%-59% of HRR) [62]. The log sheets used for the patient meetings are listed in Appendix F. After calculating the target heart rate, each participant was then asked to perform a 6 Minute Walking Test (6MWT). The goal of the 6MWT was to walk as quickly as possible for six minutes in order to cover as much distance as possible. Participants were able to stop for a rest at any time if needed [92]. The 6MWT measures a person's ability to perform activities of daily living, such as walking, stair-climbing, or shopping [61]. The 6MWT has previously been used to evaluate exercise capacity within clinical populations [93]. The 6MWT has been found to have a moderate correlation of r=0.49 (p=0.001) with VO_{2max} and an equation was developed to calculate VO_{2max} based on the 6MWT results in healthy adults that is shown in *Equation 5* [94].

$$VO_{2max}\ (ml/kg/min) = 70.161 + (0.023 \times 6MWT\ [m]) - (0.276 \times weight\ [kg]) - (6.79 \times sex,\ where\ male=0\ or\ female=1) - (0.193 \times resting\ HR\ [beats\ per\ minute]) - (0.191 \times age\ [years]) \quad \textit{Equation 5}$$

During the 6MWT, we were able to identify each participant's walking cadence needed to reach 50% of HRR ($Cadence_{mod}$) using a pedometer. When their target heart rate at a moderate intensity was achieved, the research team (*n.b.; described in the subject characteristics section*) recorded their walking cadence and RPE based on a Borg Scale from 1 to 10 [62]. The participant's walking cadence and RPE was taken again at the completion of the 6MWT. Our committee recommended that we collect accelerometer data during the 6MWT to compare the Garmin FR60 measured cadence and the accelerometer measured cadence at the time $Cadence_{mod}$ was achieved. This is important because there is currently no literature comparing the two devices. However, we were only able to get two participants to wear the accelerometer during the 6MWT because we decided to evaluate the cadence measured between the two devices near the end of our participant recruitment phase.

Once we had determined the participant's $Cadence_{mod}$, we asked the participant to walk at that pace for five minutes so they could become familiar with the cadenced-based prescription. At the end of the 5 minute walk, we used the pedometer to compare the steps taken in 5 minutes at their perceived $Cadence_{mod}$ walking pace to the prescribed steps for 5 minutes determined by $Cadence_{mod}$. At the end of the meeting, we provided the participant with their individualized cadence-based prescription sheet to take home. The cadenced-based prescription provided them with a cadence prescription (i.e. the number of steps they must take within a certain amount of time) to achieve moderate intensity. We then translated their individualized walking cadence to total number of steps for a fix period of time (e.g., 3000 steps in 30 minutes). An example of the cadence-based exercise prescription is available in Appendix G. We also reminded the participant to expect two follow-up phone calls to find out if the participant was using the cadenced-based exercise prescription and to ask for feedback regarding the CBEP intervention meeting. The two follow-up phone calls were done at 2 weeks and 6 weeks from the CBEP intervention meeting date. An example of the CBEP follow-up phone call script is available in Appendix H. Before leaving the participant, we also provided the participant with a *Piezo* pedometer if they used a different pedometer model and a copy of CPAG specific for their age group. The CPAG for adults 18 - 64 years is listed in Appendix A and the CPAG for older adults 65 years and older is in Appendix B. All 21 participants who completed the 6MWT during the intervention meeting were able to reach their target heart rate for moderate intensity by walking.

Subject characteristics

The research staff collected the following physical measures: height, weight and resting heart rate. All procedures were conducted by the research assistant and followed the *Advanced Fitness Assessment and Exercise Prescription* procedures for measurement of height, weight, and resting heart rate [61]. The research assistants have the skills, knowledge and experience with measuring the described physical measures during completion of their Kinesiology degree.

Primary outcome measure

A change in the total number of weekly minutes of MVPA performed in 10 minute bouts or longer ($MVPA_{10min}$) measured at T2 and T3, as compared to T1, was the primary outcome variable in this study. This was our primary outcome measure because the CPAG recommends accumulating 150 weekly MVPA minutes in 10 minute bouts or longer for aerobic exercise. These recommendations are based on evidence from systematic reviews to provide support that the CPAG can help achieve optimal health benefits [13, 95]. Actigraph multi-directional accelerometers were used to measure the primary outcome variable because they are accurate and reliable [50, 51] for measuring the amount, intensity, and duration of physical activity that each individual completes in their free-living environment [52]. An example of the output that the accelerometers provide can be found in Appendix I. A valid accelerometer file was defined as the participant having worn the accelerometer for at least 3 days [96]. A valid day of accelerometer data was defined as 8 or more hours of wear time. Non-wear time was defined as at least 60 consecutive minutes of zero counts between 0 and 100 [3, 97]. Wear time was defined by subtracting non-wear time from 24 hours [3, 97]. The accelerometer recorded counts in 30 second intervals. The time spent at a given intensity is based off cut-off points that are used to relate the activity during the 30 second intervals to a specific intensity [3, 97]. The specific cut-points used to distinguish sedentary, light, moderate, and vigorous intensity activities were [3, 97]:

1) Sedentary intensity cut-points: 0 – 50 counts
2) Light intensity cut-points: 50.5 -767.5 counts
3) Moderate intensity cut-points: 768 – 1981 counts
4) Vigorous intensity cut-points: 1981.5 – 999999 counts

The $MVPA_{10min}$ data was then used to classify the participant as having met or not met the aerobic exercise component of the CPAG ($MVPA_{AE\text{-}CPAG}$). In addition, we evaluated the number of total physical activity and MVPA bouts per day participants were performing for 10 minutes or longer (e.g. $TotalPA_{Bouts10min}$, $MVPA_{Bouts10min}$).

Additional outcome measures

A change in the total daily physical activity, MET-minutes per week and step counts accumulated at different intensities were measured using Actigraph multi-directional accelerometers at T0, T1, T2 and T3. Total daily physical activity and MET-minutes per week was measured in 10 minute bouts or longer ($TotalPA_{10min}$, $MET\text{-}min_{Total10min}$) and in sporadic bouts ($TotalPA_{Spor}$, $MET\text{-}min_{TotalSpor}$), which was defined as activities that were accumulated in 30 second bouts or longer. These outcomes included all the physical activity the participant accumulated at different intensities (light, moderate, and vigorous) throughout the day. Total MET-minutes per week were manually calculated by: MET level x minutes of activity x days per week. Each category of activity was assigned a given MET level (Vigorous = 8 METs; Moderate = 4 METs; Light = 3.3 METs). MVPA was also measured in sporadic bouts ($MVPA_{Spor}$).

The specific accelerometers that were utilized in this study could also measure steps (e.g., $Steps_{MVPA}$, $Steps_{Total}$), which allowed us to determine the total steps a participant performs at specific intensities each day. Strong correlations ($r=0.85$, $p<0.01$ & $r=0.87$, $p<0.01$) have been shown between accelerometer and pedometer determined step counts [98]. Therefore, we analyzed total steps per day ($Steps_{Total}$) as well as total steps per day accumulated at moderate-to-vigorous intensity ($Steps_{MVPA}$) as secondary outcomes. The $Steps_{Total}$ outcome was calculated as the sum of all the steps the participant performed at light, moderate, and vigorous intensity throughout the day. The $Steps_{Total}$ data was then used to classify the participant as having reached or not reached 10,000 steps per day ($Steps_{10,000}$). The Actigraph accelerometer has shown high interinstrument reliability for total activity counts, steps and time spent doing sedentary, light, vigorous, and MVPA intensity activities [99]. Specifically, the measurement for the amount of time spent doing activity at MVPA intensity showed an intraclass correlation coefficient, coefficient of variation, and absolute percent error was 0.99, 3.7 (0.0-12.5), and 4.9 (0.0-16.2), respectively [99].

Surveys

RFIT self-reported physical activity

The RFIT generated a report that provides information on chronic disease factors that may affect the participant's health based on the participant's responses to specific questions about certain risk behaviours. Specifically, the Pedometer project focused on the change in self-report physical activity ($RFIT_{MVPA}$) based on their answers in the physical activity section of the RFIT measured at T0, T1, T2 and T3. The self-reported physical activity data was then used to classify the participant as having met or not met the aerobic component of the CPAG ($RFIT_{AE\text{-}CPAG}$). The physical activity questions asked to gather the self-report physical activity can be found within Appendix D.

Short form-12 health survey (SF-12)

The Short Form – 12 Health Survey (SF-12) is a 12 item summary of physical and mental health components that was used to assess the change in the participant's quality of life at T0, T1, T2 and T3. The SF-12 is a shortened version of the 36-item short health survey (SF-36) and has been shown to be a reliable and valid tool at assessing quality of life [100, 101]. Participants were given a score ranging from 0-100% across physical and mental functioning scales of health in accordance with the standardized SF-12 scoring system (http://www.sf-36.org/demos/SF-12v2.html). A lower score indicates a poorer health score while a higher percent score indicates a more favourable health score.

Statistical analysis

The primary outcome variable of changes in $MVPA_{10min}$ was analyzed using a two-way ANOVA where time (T0, T1, T2, and T3) is a repeated measure and the experimental groups (SC and CBEP) are considered to be between group comparison. If differences were identified by the ANOVA, a Newman Keuls post hoc analysis was utilized to identify differences between specific means. A two-way ANOVA analysis was conducted in the same manner on other additional variables (e.g. $TotalPA_{10min}$, $TotalPA_{Spor}$, $MET\text{-}min_{Total10min}$, $MET\text{-}min_{TotalSpor}$, $MVPA_{Spor}$, $TotalPA_{Bouts10min}$, $MVPA_{Bouts10min}$, $Steps_{MVPA}$, $Steps_{Total}$, $RFIT_{MVPA}$, SF-12 physical and mental functioning) as well. Significance was accepted at $p<0.05$. We planned to test for normalcy for these variables; however, we are unaware of a non-parametric method similar to the two-way ANOVA. Therefore, we assumed the data was normally distributed in order to perform the two-way ANOVA.

Some data (e.g. Gender, Season, Questions 1, 3, 5, 8, and 9 in the intervention meeting follow-ups, $MVPA_{AE\text{-}CPAG}$, $Steps_{10,000}$, $RFIT_{AE\text{-}CPAG}$) was assessed using a 2x2 Chi-Square test and expressed in frequencies (percentage of group). Baseline characteristics and absolute (e.g. change from T1 to T2, change from T1 to T3, change from T2 to T3) and relative changes (e.g. percent change from T1 to T2, percent change from T1 to T3, percent change from T2 to T3) were tested for normalcy using the Shapiro-Wilk test (normal distribution, $p \geq 0.05$). An independent t-test was used to compare differences for baseline characteristics as well as absolute and relative changes in each of the outcome variables between SC and CBEP if the data was normally distributed. Normally distributed data were expressed as means ± standard error. Non-parametric data was analyzed using the Mann-Whitney U-test and expressed as median (25^{th} to 75^{th} percentile). We used a paired t-test to compare differences for the prescribed steps and actual steps taken at $Cadence_{mod}$ for a 5 minute walk during the CBEP intervention meeting. Furthermore, we conducted the same analysis to compare the differences in self-reported physical activity in Question 6 from the intervention meeting follow-ups (Appendix H) completed at 2 and 6 weeks. A Pearson Correlation was used to analyze the relationship between self-reported physical activity ($RFIT_{MVPA}$ and Question 6 from the intervention meeting follow-up seen in Appendix H). We excluded participants from our analysis if they dropped out of the ENCOURAGE study after T1 or if they were missing two or more data points for any of the variables. For participants who were missing one data point (e.g. missed a research follow-up appointment, invalid accelerometer days, incomplete survey and/or RFIT), we carried their last data point forward to fill the missing data point to complete the data set for all participants included in our analysis. The study population for the analysis consisted of 16 participants in SC and 19 participants in CBEP.

Chapter 3: Results

Baseline characteristics

Baseline characteristics were collected for all study participants (SC, n=16; CBEP, n=19) during their initial meeting with the CSEP-CEP and research assistants from two primary clinics in Winnipeg, MB and can be viewed in Table 2. Participant demographics, including age, gender, height, weight, and BMI did not differ between SC and CBEP.

Table 2. Comparison of baseline characteristics between the participants in the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP).

	SC	CBEP	p-value
Demographics			
Age (years)	54 (49 to 59)	50 (42 to 58)	N.S.
Gender (% female per group)	11 (69%)	13 (68%)	N.S.
Height (cm)	166 ± 2	168 ± 2	N.S.
Weight (kg)	99 (89 to 109)	107 (96 to 118)	N.S.
BMI (kg/m^2)	36 ± 1	39 ± 1	N.S.

Continuous variables expressed as mean ± standard error (e.g., height, BMI) or median (25^{th} to 75^{th} percentile; e.g., age, weight). Categorical variables expressed in frequencies (percentage of group). *SC*, Standard Care group n=16; *CBEP*, Cadenced-Based Exercise Prescription group n=19. *BMI*, body mass index.

The number of participants that began the ENCOURAGE study in each month is shown in Table 3. Furthermore, we divided the experimental groups into seasons. The seasonal group the participants were placed in was determined by their starting month. Participants were placed in the Spring/Summer group if they began the ENCOURAGE study in March to August; and the Fall/Winter group if they began in September to

February. The range of months used for each seasonal group was utilized because it defined the season that the participants would be spending a majority of the Pedometer project in. During our Chi-Square test analysis, we found no differences between SC and CBEP for the number of participants that was classified into each seasonal group.

Table 3. The month when the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) started the ENCOURAGE study at baseline (T0).

	SC	CBEP
Month		
January	5 (31%)	0 (0%)
February	0 (0%)	1 (5%)
March	1 (6%)	3 (16%)
April	1 (6%)	6 (32%)
May	3 (19%)	4 (21%)
June	2 (13%)	0 (0%)
July	1 (6%)	2 (11%)
August	2 (13%)	0 (0%)
September	0 (0%)	1 (5%)
October	1 (6%)	1 (5%)
November	0 (0%)	1 (5%)
December	0 (0%)	0 (0%)
Season		
Spring/Summer (March to August)	10 (62%)	15 (79%)
Fall/Winter (September to February)	6 (38%)	4 (21%)

Categorical variables expressed in frequencies (percentage of group). *SC*, Standard Care group n=16; *CBEP*, Cadenced-Based Exercise Prescription group n=19. *T0*, baseline time point.

Intervention meeting and follow-up data

During the intervention meeting that was scheduled two weeks after T1, we collected data for baseline measures of the 19 CBEP participants before performing the 6MWT

(Table 4). In addition, we recorded the information from the 6MWT and the 5 minute walk that was completed in order to compare the prescribed steps for a 5 minute walk to the actual steps taken during the 5 minute walk at $Cadence_{mod}$. We found that the average prescribed cadence for 50% HRR was 126 ± 2 steps per minute. Furthermore, the CBEP participants reported a Borg Scale rating of 4 ± 0.4 when they reached 50% HRR. The average 6MWT distance was 554 ± 14 metres for CBEP. We calculated VO_{2Max} (ml/kg/min) using *Equation 5* [94] and found a VO_{2Max} of 24 ± 1 ml/kg/min. When we looked at the 5 minute walk results, we found the difference between the prescribed steps (632 ± 9) and actual steps (616 ± 13) taken over the 5 minutes was 17 ± 9 steps. Furthermore, we performed a paired t-test to compare differences in the prescribed steps at $Cadence_{mod}$ for a 5 minute walk and the actual steps taken at $Cadence_{mod}$ during a 5 minute walk. The results showed no significant difference between the prescribed steps and actual steps taken for a 5 minute walk at $Cadence_{mod}$ during the CBEP intervention meeting.

Table 4. Cadenced-Based Exercise Prescription group (CBEP) results during the intervention meeting.

	CBEP
Baseline Measures	
Do you think you are reaching moderate intensity when you currently exercise? (% Yes per group)	13 (68%)
HR_{max} (beats/min)	173 ± 2
HR_{rest} (beats/min)	80 ± 3
HRR (beats/min)	93 ± 3
6MWT	
Target HR at 50% HRR (beats/min)	127 ± 2
$Cadence_{mod}$ (steps/min)	126 ± 2
Borg Scale Rating at $Cadence_{mod}$	4 ± 0.4
6MWT Final HR (beats/min)	138 ± 3
6MWT Final Cadence (steps/min)	125 ± 2
6MWT Final Borg Scale Rating	6 ± 0.4
6MWT Distance (m)	554 ± 14
VO_{2Max} (ml/kg/min)	24 ± 1
5 Minute Walk	
Prescribed $Cadence_{mod}$ (steps/min)	126 ± 2
Prescribed steps at $Cadence_{mod}$ for a 5 minute walk (steps)	632 ± 9
Actual steps at $Cadence_{mod}$ during a 5 minute walk (steps)	616 ± 13
Difference between prescribed steps and actual steps during a 5 minute walk (steps)	17 ± 9

Continuous variables expressed as mean ± standard error. Categorical variables expressed in frequencies (percentage of group). *CBEP*, Cadenced-Based Exercise Prescription group n=19. HR_{max}, maximum heart rate; HR_{rest}, resting heart rate; *HRR*, heart rate reserve; $Cadence_{mod}$, cadence when target HR at 50% of HRR is achieved; *6MWT*, 6 minute walking test; VO_{2Max}, maximum oxygen consumption.

We performed a sub-analysis on two participants that wore their accelerometer during the 6MWT and observed that the cadence measured by the Garmin FR60 and accelerometer at 50% HRR was achieved was similar (Table 5). Participant #1 had a cadence of 120 steps per minute and 121 steps per minute at 50% HRR measured using the Garmin FR60 and accelerometer, respectively. Furthermore, Participant #2 achieved a cadence of 130 steps per minute using the Garmin FR60 and 132 steps per minute using the accelerometer when 50% HRR was reached. Therefore, it appears that the accelerometer cut-points used to identify $\text{Steps}_{\text{MVPA}}$ was appropriate to use with our study population.

Table 5. Cadence measured by the Garmin FR60 device and the accelerometer at the time target heart rate (HR) at 50% of heart rate reserve (HRR) is achieved that was completed with two participants.

	Garmin FR60	Accelerometer
CBEP		
$\text{Cadence}_{\text{mod}}$ (steps/min)		
Participant #1	*120*	*121*
Participant #2	*130*	*132*

Values expressed as steps/min. *CBEP*, Cadenced-Based Exercise Prescription group n=2. *HRR*, heart rate reserve; $\textit{Cadence}_{mod}$, cadence when target HR at 50% of HRR is achieved.

After the intervention meeting, the CBEP participants completed two follow-up phone calls at 2 and 6 weeks. The phone calls consisted of questions described in Appendix H and Table 6. The answers were then grouped together to fit common themes in Table 6. Ninety-five percent of the CBEP group reported that they continued using the pedometer 2 and 6 weeks after the intervention. One participant did not use a pedometer because they did not find it useful. For the people that did use the pedometer, 37% and 32% of the CBEP participants used the pedometer only while walking for exercise at 2 weeks and 6 week follow-up, respectively. At both follow-ups, the remaining participants reported wearing the pedometer all day, everyday. In addition, all of the

CBEP participants that used the pedometer reported that they liked the new method for tracking exercise intensity using the pedometer when asked at 2 week follow-up. The one participant who did not use the pedometer thought they would like the new method for tracking exercise intensity if they used the pedometer. However, only 74% of the CBEP participants reported liking this method when asked at 6 week follow-up. It was also notable that 63% and 79% of the CBEP participants did not report any challenges of using the pedometer for exercise at 2 week and 6 week follow-up, respectively. Fifty-three percent and sixty-eight percent of the CBEP participants felt motivated to do more physical activity because of the cadenced-based prescription when asked at 2 weeks and 6 weeks, respectively. The CBEP participants reported spending 287 ± 135 minutes per week and 286 ± 139 minutes per week walking at 2 week and 6 week follow-up, respectively. Moreover, 37% of the CBEP participants preferred trying to reach the prescribed steps per minute to reach moderate intensity goal rather than trying to reach 10,000 steps per day at both follow-ups. It was also notable that 74% and 100% of the CBEP participants reported being motivated by the intervention (i.e. meeting itself) to participate in more physical activity at 2 week and 6 week follow-up, respectively. Furthermore, 95% and 100% of the CBEP participants reported the intervention meeting helpful at 2 week and 6 week follow-up, respectively. The one person at 2 week follow-up that did not find the meeting helpful said it was because they did not understand the concept of the intervention meeting.

We conducted a Chi-Square Test to compare the number of participants that answered "yes" or "no" for Questions 1, 3, 5, 8, and 9 in the CBEP intervention meeting follow-ups. If the participant answered "not sure" then we considered that as a "no" answer.

This would allow us to perform the 2x2 Chi-Square Test analyses. There was no difference at 2 (95%) and 6 (95%) week follow-up for the number of participants using a pedometer after meeting with the researchers. In addition, no difference was found for the number of participants liking the new method of tracking exercise intensity at 2 (100%) and 6 (74%) week follow-up. When we analyzed Questions 5 and 8 regarding motivation, there was no difference between the number of participants that reported being motivated to participate in more physical activity because of CBEP and the intervention (i.e. meeting itself) at 2 (CBEP, 53%; intervention, 74%) and 6 (CBEP, 68%; intervention, 100%) weeks after the CBEP intervention meeting. Moreover, no difference was found in the number of participants that found the intervention meeting helpful at 2 (95%) and 6 (100%) week follow-up. Furthermore, we performed a paired t-test to compare differences in weekly minutes of self-reported physical activity at 2 and 6 week follow-up. The results showed no significant difference between the weekly minutes of self-reported physical activity 2 and 6 weeks after the CBEP intervention meeting.

Table 6. Results from the CBEP participants' intervention meeting follow-ups completed at 2 and 6 weeks.

	2 Weeks	6 Weeks
Follow-up Data		
Q1: Have you been using the pedometer since your meeting with the researchers?		
Yes	18 (95%)	18 (95%)
No	1 (5%)	1 (5%)
Don't find it useful	*1 (5%)*	*1 (5%)*
Q2: When are you wearing the pedometer?		
All day (including exercise period)	11 (58%)	12 (63%)
Exercise period only	7 (37%)	6 (32%)
Not applicable (i.e. did not use pedometer)	1 (5%)	1 (5%)
Q3: Do you like this new method of tracking exercise intensity?		
Yes	19 (100%)	14 (74%)
No	0 (0%)	2 (11%)
Not sure	0 (0%)	3 (16%)
Q4: What are the main challenges to using the pedometer for exercise alone?		
Not enough time	2 (11%)	2 (11%)
Don't find it useful	2 (11%)	0 (0%)
Too hard to keep track of	2 (11%)	1 (5%)
Doctor said not to increase intensity	1 (5%)	0 (0%)
Other (Did not specify)	0 (0%)	1 (5%)
None	12 (63%)	15 (79%)
Q5: Is the steps per minute prescription motivating you to do more physical activity?		
Yes	10 (53%)	13 (68%)
No	6 (32%)	5 (26%)
Not sure	3 (16%)	1 (5%)
Q6: How many minutes of walking have you been doing in one week on average? (self-reported)[#]	287 ± 135	286 ± 139

Q7: Which goal do you prefer?		
Trying to reach 10,000 steps per day	5 (26%)	6 (32%)
Trying to reach the prescribed steps per minute to reach moderate intensity	7 (37%)	7 (37%)
Both	6 (32%)	6 (32%)
Neither	1 (5%)	0 (0%)
Q8: Did the intervention in general motivate you to do more physical activity?		
Yes	14 (74%)	19 (100%)
No	3 (16%)	0 (0%)
Not sure	2 (11%)	0 (0%)
Q9: Overall, did you find the intervention meeting helpful?		
Yes	18 (95%)	19 (100%)
Motivational	*9 (47%)*	*7 (37%)*
Provides structures and goals	*3 (16%)*	*4 (21%)*
Determines baseline activity levels	*1 (5%)*	*1 (5%)*
Informative	*5 (26%)*	*6 (32%)*
Encouraged by the researchers	*0 (0%)*	*1 (5%)*
No	1 (5%)	0 (0%)
Did not understand	*1 (5%)*	*0 (0%)*

Continuous variables expressed as mean ± standard error. Categorical variables expressed in frequencies (percentage of group). *CBEP*, Cadenced-Based Exercise Prescription group n=19. #, CBEP n=17 for that question because the question was added after the first two CBEP participants completed 2 week and 6 week follow-up.

Accelerometer physical activity

Physical activity was assessed by accelerometers and the different parameters are displayed in Table 7 and Table 8. Physical activity was analyzed in 10 minute bouts or longer (e.g. $TotalPA_{10min}$, $MVPA_{10min}$ and $MET\text{-}min_{Total10min}$) and also in sporadic bouts of activity (e.g. $TotalPA_{Spor}$, $MVPA_{spor}$ and $MET\text{-}min_{TotalSpor}$). Steps were also analyzed in sporadic bouts (e.g. $Steps_{MVPA}$ and $Steps_{Total}$). Valid accelerometer data was collected in 15 participants in SC and 17 participants in CBEP at the four time points (T0, T1, T2, T3).

When accelerometer data was analyzed in 10 minute bouts ($TotalPA_{10min}$, $MVPA_{10min}$, $MET\text{-}min_{Total10min}$; Table 7), there were no differences at T0 between SC and CBEP. Time had no effect on SC and CBEP for $TotalPA_{10min}$, $MVPA_{10min}$, and $MET\text{-}min_{Total10min}$. There were no differences observed for any intensity of activity (i.e. $TotalPA_{10min}$ and $MVPA_{10min}$) between SC and CBEP at any time. Furthermore, no differences between SC and CBEP were found for $MET\text{-}min_{Total10min}$ at any time. Likewise, there were no significant absolute changes at T1 to T2, T1 to T3, and T2 to T3 between SC and CBEP for any accelerometer data analyzed in 10 minute bouts ($TotalPA_{10min}$, $MVPA_{10min}$, $MET\text{-}min_{Total10min}$; Appendix J). When participants were categorized for meeting the aerobic exercise component of the CPAG based on their $MVPA_{10min}$ (e.g. $MVPA_{AE\text{-}CPAG}$) there was no difference at T0 between SC (0%) and CBEP (0%). No differences were observed between SC and CBEP for $MVPA_{AE\text{-}CPAG}$ at any time. Furthermore, we analyzed the number of total physical activity and MVPA bouts per day that participants were performing for 10 minutes or longer (e.g. $TotalPA_{Bouts10min}$, $MVPA_{Bouts10min}$). Our results showed no differences for $TotalPA_{Bouts10min}$ and $MVPA_{Bouts10min}$ at T0 between SC and CBEP. There was no time effect for $TotalPA_{Bouts10min}$ and $MVPA_{Bouts10min.}$ Moreover, no differences were observed for $TotalPA_{Bouts10min}$ and $MVPA_{Bouts10min}$ between SC and CBEP at any time point.

When accelerometer physical activity was assessed based on sporadic bouts of activity lasting 30 seconds or longer ($TotalPA_{Spor}$, $MVPA_{spor}$; Table 8), there were no differences at T0 between SC and CBEP. Time had no effect for $TotalPA_{Spor}$ and $MVPA_{spor}$. For $TotalPA_{Spor}$ and $MVPA_{spor}$, no differences were observed between SC and CBEP at any time. There were no differences in absolute changes at T1 to T2, T1 to T3, and T2 to T3 for $TotalPA_{Spor}$, $MVPA_{spor}$, and $MET\text{-}min_{TotalSpor}$ between SC and CBEP (Appendix K). Likewise, the relative changes for $TotalPA_{Spor}$ and $MVPA_{spor}$ between SC and CBEP were not significant at T1 to T2, T1 to T3, and T2 to T3. At T0, $MET\text{-}min_{TotalSpor}$ did not differ between SC and CBEP. However, a main effect of time for $MET\text{-}min_{TotalSpor}$ was found, where T0, T1 > T2, T3 ($p<0.05$). However, there was no difference between SC and CBEP for $MET\text{-}min_{TotalSpor}$. No differences were observed for $MET\text{-}min_{TotalSpor}$ between SC and CBEP for relative changes at T1 to T2, T1 to T3, and T2 to T3.

Table 7. Comparison of physical activity measured in 10 minute bouts between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
10 Minute Bouts				
$TotalPA_{10min}$ (mins/week)				
SC	48 ± 16	90 ± 41	71 ± 30	41 ± 10
CBEP	37 ± 10	44 ± 15	48 ± 11	47 ± 14
$MVPA_{10min}$ (mins/week)				
SC	21 ± 12	30 ± 26	36 ± 28	16 ± 9
CBEP	22 ± 8	25 ± 15	30 ± 11	28 ± 12
$MET\text{-}min_{Total10min}$ (MET-min/week)				
SC	176 ± 64	295 ± 158	293 ± 192	109 ± 27
CBEP	140 ± 40	181 ± 66	148 ± 30	146 ± 43
$MVPA_{AE\text{-}CPAG}$				
SC	0 (0%)	1 (7%)	1 (7%)	0 (0%)
CBEP	0 (0%)	1 (6%)	1 (6%)	1 (6%)
$TotalPA_{Bouts10min}$ (bouts/day)				
SC	0.5 ± 0.2	0.5 ± 0.2	0.5 ± 0.1	0.4 ± 0.1
CBEP	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1
$MVPA_{Bouts10min}$ (bouts/day)				
SC	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
CBEP	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1

Values are means ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (Percentage of group). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *MVPA*, moderate to vigorous physical activity; *MET*, metabolic equivalent; $MVPA_{AE\text{-}CPAG}$, met the aerobic exercise recommendations in the Canadian Physical Activity Guidelines based on $MVPA_{10min}$; $TotalPA_{Bouts10min}$, number of bouts of total physical activity performed for 10 minutes or longer per day; $MVPA_{Bouts10min}$, number of bouts of moderate to vigorous physical activity performed for 10 minutes or longer per day.

Table 8. Comparison of sporadic physical activity between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
Sporadic Bouts				
$TotalPA_{Spor}$ (mins/week)				
SC	**1186 ± 150**	**1342 ± 118**	**1128 ± 144**	**1200 ± 158**
CBEP	**1226 ± 94**	**1230 ± 105**	**1189 ± 104**	**1204 ± 105**
Relative Change				
T2-T1/T1				
SC	-	-	***-15 ± 7%***	-
CBEP	-	-	***-0.2 ± 6%***	-
T3-T1/T1				
SC	-	-	-	***-4 (-16 to 24%)***
CBEP	-	-	-	***-8 (-30 to 14%)***
T3-T2/T2				
SC	-	-	-	***0 (-11 to 11%)***
CBEP	-	-	-	***0 (-13 to 13%)***
$MVPA_{Spor}$ (mins/week)				
SC	**124 ± 21**	**122 ± 26**	**95 ± 31**	**99 ± 20**
CBEP	**139 ± 19**	**150 ± 25**	**134 ± 18**	**129 ± 19**
Relative Change				
T2-T1/T1				
SC	-	-	***-41 (-85 to 3%)***	-
CBEP	-	-	***-11 (-57 to 35%)***	-
T3-T1/T1				
SC	-	-	-	***-19 (-49 to 11%)***
CBEP	-	-	-	***-17 (-55 to 21%)***
T3-T2/T2				
SC	-	-	-	***4 (-35 to 43%)***
CBEP	-	-	-	***- 5 (-26 to 16%)***

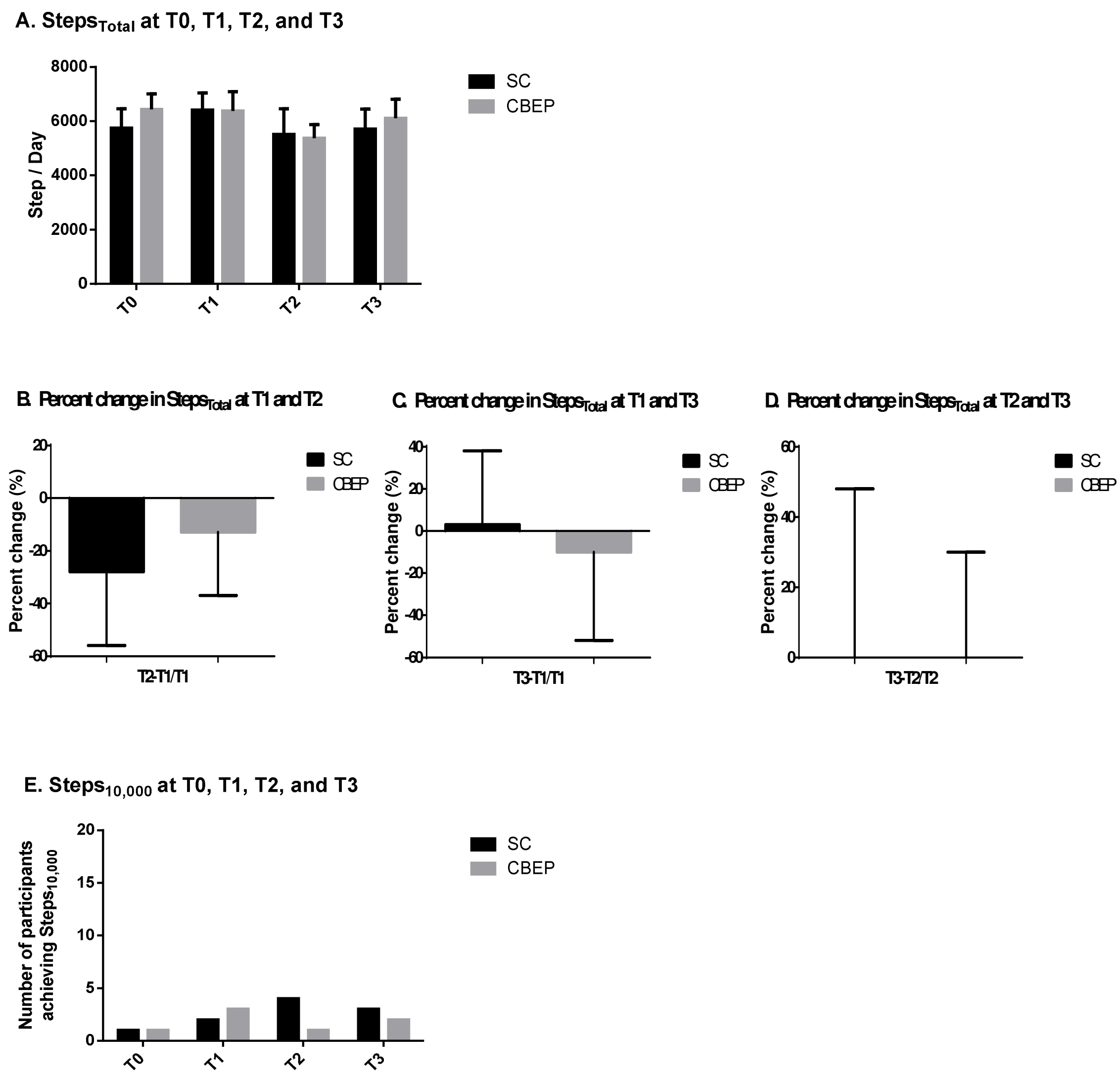
MET-min$_{TotalSpor}$ (MET-min/week)				
SC	**3528 ± 488**	**3530 ± 362**	**2894 ± 492**	**3025 ± 461**
CBEP	**3998 ± 287**	**4260 ± 413**	**3159 ± 284**	**3213 ± 347**
Relative Change				
T2-T1/T1				
SC	**-**	**-**	***-32 (-49 to -15%)***	**-**
CBEP	**-**	**-**	***-27 (-55 to 1%)***	**-**
T3-T1/T1				
SC	**-**	**-**	**-**	***-24 (-50 to 2%)***
CBEP	**-**	**-**	**-**	***-34 (-48 to -20%)***
T3-T2/T2				
SC	**-**	**-**	**-**	***0 (-38 to 38%)***
CBEP	**-**	**-**	**-**	***0 (-30 to 30%)***

Values are means ± standard error or median (25th to 75th percentile). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity; *MET*, metabolic equivalent. Time effect for MET-min$_{TotalSpor}$ where T0, T1 > T2, T3 ($p<0.05$).

When we analyzed the accelerometer data for Steps$_{Total}$ (Figure 4), there was no difference at T0 between SC (5751 ± 711 steps) and CBEP (6439 ± 572 steps). Time had no effect for Steps$_{Total}$. No difference was found between SC (T0, 5751 ± 711 steps; T1, 6417 ± 627 steps; T2, 5515 ± 943 steps; T3, 5712 ± 740 steps) and CBEP (T0, 6439 ± 572 steps; T1, 6379 ± 709 steps; T2, 5370 ± 500 steps; T3, 6102 ± 702 steps) for Steps$_{Total}$ at any time (Figure 4A). There was no significant difference between SC and CBEP for absolute changes in Steps$_{Total}$ at T1 to T2, T1 to T3, and T2 to T3 (Appendix L). Moreover, the relative changes in Steps$_{Total}$ at T1 to T2, T1 to T3, and T2 to T3 were not different between SC and CBEP (Figure 4B, 4C, 4D).

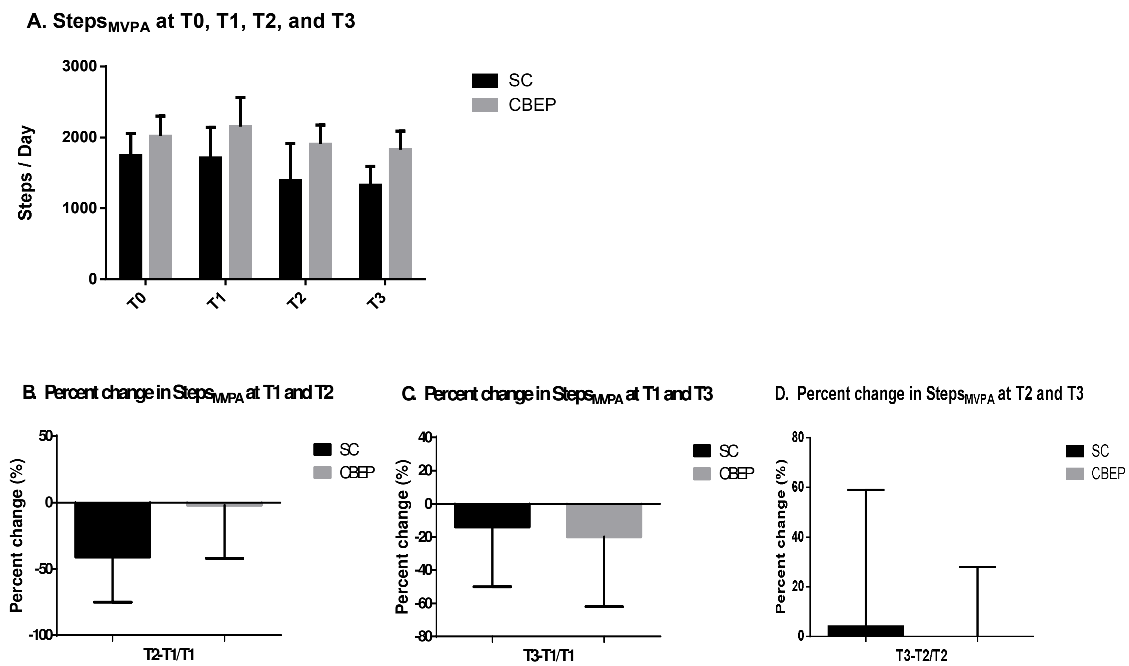
When participants were categorized for reaching 10,000 steps per day based on their $Steps_{Total}$ (e.g. $Steps_{10,000}$), there was no difference at T0 between SC (7%) and CBEP (6%), as seen in Figure 4E. No differences were observed between SC and CBEP for $Steps_{10,000}$ at any time.

Figure 4: We had the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) wear accelerometers for a week and measured the total number of steps they took per day. Values are mean ± standard error (Panel A) or median (25^{th} to 75^{th} percentile; Panel B to D). Categorical variables expressed in frequencies (percentage of group; Panel E). *SC*, Standard Care group n = 15; *CBEP*, Cadenced-Based Exercise Prescription group n = 17. A. $Steps_{Total}$ at T0, T1, T2, and T3. B. Percent change in $Steps_{Total}$ at T1 and T2. C. Percent change in $Steps_{Total}$ at T1 and T3. D. Percent change in $Steps_{Total}$ at T2 and T3. E. $Steps_{10,000}$ at T0, T1, T2, and T3. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *$Steps_{10,000}$*, reached 10,000 total steps per day.



When we analyzed $Steps_{MVPA}$ (Figure 5), there was no difference at T0 between SC (1742 ± 315 steps) and CBEP (2019 ± 283 steps). Time had no effect for $Steps_{MVPA}$. Likewise, there was no group effects observed for $Steps_{MVPA}$ (Figure 5A). No differences were observed for absolute changes between SC and CBEP for $Steps_{MVPA}$ at T1 to T2, T1 to T3, and T2 to T3 (Appendix M). Likewise, there were no differences between SC and CBEP for $Steps_{MVPA}$ when comparing the relative changes from T1 (Figure 5B, 5C, 5D).

Figure 5: We compared the number of moderate-to-vigorous (MVPA) steps taken per day by the Standard Care group (SC) and Cadenced-Based Exercise Prescription (CBEP) that was measured using accelerometers. Values are mean ± standard error (Panel A) or median (25th to 75th percentile; Panel B to D). *SC*, Standard Care group n = 15; *CBEP*, Cadenced-Based Exercise Prescription group n = 17. A. $Steps_{MVPA}$ at T0, T1, T2, and T3. B. Percent change in $Steps_{MVPA}$ at T1 and T2. C. Percent change in $Steps_{MVPA}$ at T1 and T3. D. Percent change in $Steps_{MVPA}$ at T2 and T3. MVPA, moderate to vigorous physical activity; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point.



RFIT self-reported physical activity

Participant self-reported physical activity was captured using the RFIT (e.g., $RFIT_{MVPA}$; Table 9). There were 10 participants in SC and 13 participants in CBEP that completed the RFIT at all four time points. For $RFIT_{MVPA}$, there was no statistical difference at T0 between SC (322 ± 200 minutes per week) and CBEP (668 ± 266 minutes per week). Time had no effect on $RFIT_{MVPA}$ in SC and CBEP. There were no differences between SC and CBEP for $RFIT_{MVPA}$ at the four time points. Furthermore, there were no differences in absolute changes at T1 to T2, T1 to T3, and T2 to T3 for $RFIT_{MVPA}$ between SC and CBEP (Appendix N). There was a significant correlation between the self-reported physical activity in $RFIT_{MVPA}$ and Question 6 of the intervention meeting follow-up (r=0.73; p=0.004; Figure 6; Appendix H).

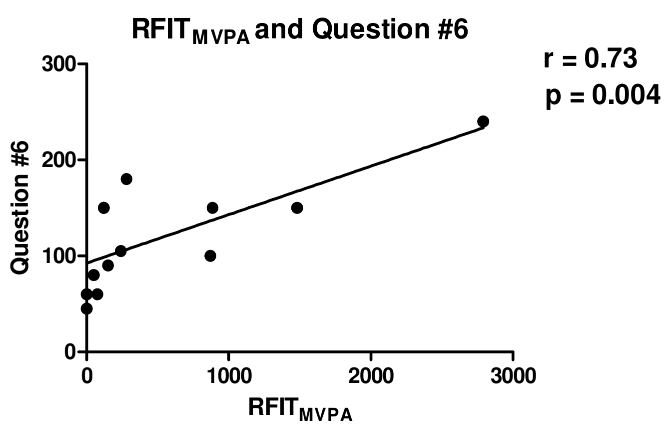
When participants were categorized for meeting the aerobic exercise component of the CPAG based on their self-reported physical activity (e.g., $RFIT_{AE\text{-}CPAG}$), there was no difference at T0 between SC (40%) and CBEP (46%). No differences were observed between SC and CBEP for $RFIT_{AE\text{-}CPAG}$ at any time. Although not statistically significant based on the Chi-Square test, it should be indicated that at T3 more participants were meeting the aerobic exercise recommendations of the CPAG based on $RFIT_{MVPA}$ in CBEP (n=10), as compared to SC (n=5).

Table 9. Comparison of self-reported physical activity between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) using the Risk Factor Identification Tool (RFIT) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
$RFIT_{MVPA}$ (mins/week)				
SC	322 ± 200	576 ± 234	466 ± 167	312 ± 163
CBEP	668 ± 266	543 ± 225	589 ± 248	639 ± 277
$RFIT_{AE\text{-}CPAG}$				
SC	4 (40%)	8 (80%)	7 (70%)	5 (50%)
CBEP	6 (46%)	7 (54%)	7 (54%)	10 (77%)

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (percentage of group). *SC*, Standard Care group n=10; *CBEP*, Cadenced-Based Exercise Prescription group n=13. *MVPA*, moderate to vigorous physical activity; *$RFIT_{AE\text{-}CPAG}$*, met the aerobic exercise recommendation in the Canadian Physical Activity Guidelines; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point.

Figure 6. Correlation between self-reported physical activity from RFIT moderate-to-vigorous physical activity at 8 weeks (T1) and question #6 from follow-up 2 weeks after the intervention meeting. Association between $RFIT_{MVPA}$ at T1 and Question #6 at 2 week intervention meeting follow-up. n= 13 XY data points. There was a significant correlation between $RFIT_{MVPA}$ and Question #6 from the intervention follow-up (r=0.73; p=0.004). *MVPA*, moderate to vigorous physical activity.



SF-12 health survey

The SF-12 health survey was utilized to determine whether there were differences over time between the groups for their physical and mental health components of quality of life over time (Table 10). There were 16 participants in SC and 19 participants in CBEP that completed the SF-12 health survey at all four time points. SF-12 Physical functioning was not different at T0 between SC (38 ± 3%) and CBEP (42 ± 2%). A main effect of time was found for SF-12 physical functioning, where T0 < T1, T3 ($p<0.05$). There were no differences between SC and CBEP for SF-12 physical functioning at any time point. In addition, there were no differences in absolute changes at T1 to T2 and T1 to T3 for SF-12 physical functioning between SC and CBEP (Appendix O). There was a trend ($p=0.06$), however, towards a difference in absolute change at T2 to T3 for SF-12 physical functioning between SC and CBEP (Appendix O). When relative change was analyzed for SF-12 physical functioning, no differences were found for relative changes at T1 to T2 and T1 to T3 for SF-12 physical functioning between SC and CBEP. There was a trend ($p=0.09$) for relative change at T2 to T3 for SF-12 physical functioning between SC and CBEP.

When we analyzed SF-12 mental functioning, SF-12 mental functioning was not different at T0 between SC (46 ± 3%) and CBEP (47 ± 3%). Time had no effect on SF-12 mental functioning. There were no differences for SF-12 mental functioning between groups over time. Furthermore, there were no absolute changes that were significant for SF-12 mental functioning between SC and CBEP at T1 to T2, T1 to T3, and T2 to T3 (Appendix O). Likewise, no differences were found for relative changes at T1 to T2, T1 to T3 and T2 to T3 for SF-12 mental functioning between SC and CBEP.

Table 10. Comparison of self-reported quality of life between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) using the Short-form 12 quality of life questionnaire (SF-12) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
SF-12 Survey Data				
Physical functioning				
SC	**38 ± 3%**	**44 ± 3%**	**43 ± 3%**	**40 ± 3%**
CBEP	**42 ± 2%**	**44 ± 2%**	**43 ± 3%**	**45 ± 3%**
Relative Change				
T2-T1/T1				
SC	-	-	***-0.4 ± 4%***	-
CBEP	-	-	***-2 ± 5%***	-
T3-T1/T1				
SC	-	-	-	***-7 ± 4%***
CBEP	-	-	-	***2 ± 4%***
T3-T2/T2				
SC	-	-	-	***-10 (-24 to 4%)***
CBEP	-	-	-	***5 (-7 to 17%)***
Mental functioning				
SC	**46 ± 3%**	**45 ± 3%**	**48 ± 3%**	**50 ± 3%**
CBEP	**47 ± 3%**	**49 ± 2%**	**52 ± 3%**	**50 ± 3%**
Relative Change				
T2-T1/T1				
SC	-	-	***2 (-12 to 16%)***	-
CBEP	-	-	***6 (-10 to 22%)***	-
T3-T1/T1				
SC	-	-	-	***8 (-12 to 28%)***
CBEP	-	-	-	***3 (-20 to 26%)***
T3-T2/T2				
SC	-	-	-	***4 (-8 to 16%)***
CBEP	-	-	-	***3 (-5 to 11%)***

Values are mean ± standard error or median (25th to 75th percentile). *SC*, Standard Care group n=16; *CBEP*, Cadenced-Based Exercise Prescription n=19. *SF-12*, Short-form 12 Questionnaire; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point. Time effect for physical functioning where T0 < T1, T3 ($p<0.05$).

Analysis of MVPA steps per day in different population sub-groups

We conducted a sub-analysis of $Steps_{MVPA}$ by pooling together SC (n=15) and CBEP (n=17) accelerometer data and broke them down into different categories based on the median and classification for the variables in their baseline characteristics (Table 11 to Table 15). Therefore, we pooled the data for 32 participants to complete the sub-analyses for $Steps_{MVPA}$ in the different population sub-groups. The categories were gender (Table 11), age (median = 52 years; Table 12), weight (median = 103 kg; Table 13), body mass index (BMI; median = 36 kg/m^2; Table 14), and the season they participated in the study (Figure 7).

The gender category (Table 11) was based on the participant classification of being female or male. We had 22 females and 10 males for this sub-analysis. At T0, $Steps_{MVPA}$ for females was 2199 ± 255 steps and for males it was 1209 ± 264 steps. A main effect of group was observed for $Steps_{MVPA}$ based on gender, where female > male ($p<0.05$). However, no effect of time was observed for $Steps_{MVPA}$. Furthermore, no interaction effect observed. Females and males did not differ in absolute changes for $Steps_{MVPA}$ at T1 to T2, T1 to T3 and T2 to T3 (Appendix P). Likewise, no differences were found for relative changes for $Steps_{MVPA}$ at T1 to T2, T1 to T3, and T2 to T3 between females and males.

Table 11. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them by their gender to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Gender				
Female	**2199 ± 255**	**2383 ± 370**	**1997 ± 371**	**1759 ± 233**
Male	**1209 ± 264**	**983 ± 327**	**929 ± 299**	**1227 ± 303**
Relative Change				
T2-T1/T1				
Female	-	-	***-11 (-45 to 23%)***	-
Male	-	-	***-24 (-117 to 69%)***	-
T3-T1/T1				
Female	-	-	-	***-20 (-55 to 15%)***
Male	-	-	-	***-0.4 (-94 to 94%)***
T3-T2/T2				
Female	-	-	-	***0 (-37 to 37%)***
Male	-	-	-	***2 (-25 to 29%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them by gender. Female n=22; Male n=10. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity. Group effect for gender where female > male (p<0.05).

The age category (Table 12) was based on the median age of 52 years. There were 16 participants in both Age_{young} (age below or equal to 52 years) and Age_{old} (age above 52 years). At T0, no difference was found for $Steps_{MVPA}$ between Age_{young} (2185 ± 244 steps) and Age_{old} (1593 ± 330 steps). There was no effect of time observed for $Steps_{MVPA}$. Furthermore, no interaction effect was observed. No difference was shown in $Steps_{MVPA}$ between Age_{young} and Age_{old} for absolute changes at T1 to T2, T1 to T3 and T2 to T3 (Appendix Q). Likewise, no differences were observed in $Steps_{MVPA}$ for relative changes at T1 to T2, T1 to T3, and T2 to T3 between Age_{young} and Age_{old}.

Table 12. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their age being below, equal to, or above the median age of 52 years to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	**T1**	**T2**	**T3**
Age (52 years)				
Age_{young}	**2185 ± 244**	**2287 ± 424**	**1888 ± 245**	**1888 ± 250**
Age_{old}	**1593 ± 330**	**1604 ± 405**	**1439 ± 515**	**1298 ± 270**
Relative Change				
T2-T1/T1				
Age_{young}	-	-	***-5 (-38 to 28%)***	-
Age_{old}	-	-	***-20 (-60 to 20%)***	-
T3-T1/T1				
Age_{young}	-	-	-	***-13 (-50 to 24%)***
Age_{old}	-	-	-	***-19 (-57 to 19%)***
T3-T2/T2				
Age_{young}	-	-	-	***0 (-23 to 23%)***
Age_{old}	-	-	-	***3 (-53 to 59%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their age being below, equal to, or above the median age of 52 years. Age_{young} n=16; Age_{old} n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity.

The weight category (Table 13) was based on the median of weight of 103 kg. There were 16 participants each in the two groups, $Weight_{under}$ (weight under or equal to 103 kg) and $Weight_{over}$ (weight over 103 kg). No difference was found at T0 for $Steps_{MVPA}$ between $Weight_{under}$ (2080 ± 355 steps) and $Weight_{over}$ (1699 ± 221 steps). There was no time effect for $Steps_{MVPA}$. Moreover, no interaction effect was observed. $Weight_{under}$ and $Weight_{over}$ showed no differences in $Steps_{MVPA}$ for absolute changes at T1 to T2, T1 to T3, and T2 to T3 (Appendix R). Furthermore, no differences were found between $Weight_{under}$ and $Weight_{over}$ for $Steps_{MVPA}$ for relative changes at T1 to T2, T1 to T3, and T2 to T3.

Table 13. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their weight being under, equal to, or over the median weight of 103 kg to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Weight (103 kg)				
$Weight_{under}$	**2080 ± 355**	**1793 ± 433**	**1825 ± 514**	**1675 ± 221**
$Weight_{over}$	**1699 ± 221**	**2098 ± 411**	**1502 ± 252**	**1511 ± 312**
Relative Change				
T2-T1/T1				
$Weight_{under}$	-	-	***2 (-63 to 67%)***	-
$Weight_{over}$	-	-	***-15 (-38 to 8%)***	-
T3-T1/T1				
$Weight_{under}$	-	-	-	***-9 (-72 to 54%)***
$Weight_{over}$	-	-	-	***-35 (-72 to 2%)***
T3-T2/T2				
$Weight_{under}$	-	-	-	***11 (-82 to 104 %)***
$Weight_{over}$	-	-	-	***0 (-11 to 11%)***

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their weight being under, equal to, or over the median weight of 103 kg. $Weight_{under}$ n=16; $Weight_{over}$ n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity.

The BMI category (Table 14) was based on the median BMI of 36 kg/m^2. There were 16 participants in the groups BMI_{under} (BMI under or equal to 36 kg/m^2) and BMI_{over} (BMI over 36 kg/m^2). No difference was found at T0 for $Steps_{MVPA}$ between BMI_{under} (1954 ± 323 steps) and BMI_{over} (1825 ± 273 steps). There was no effect of time observed for $Steps_{MVPA}$. The analysis for the BMI category for $Steps_{MVPA}$ showed no difference between BMI_{under} and BMI_{over} at any time. No significant differences were observed for absolute changes at T1 to T2, T1 to T3, and T2 to T3 between BMI_{under} and BMI_{over} (Appendix S). Likewise, no differences were found for relative changes at T1 to T2, T1 to T3, and T2 to T3 between BMI_{under} and BMI_{over}.

Table 14. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their BMI being under, equal to, or over the median BMI of 36 kg/m^2 to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

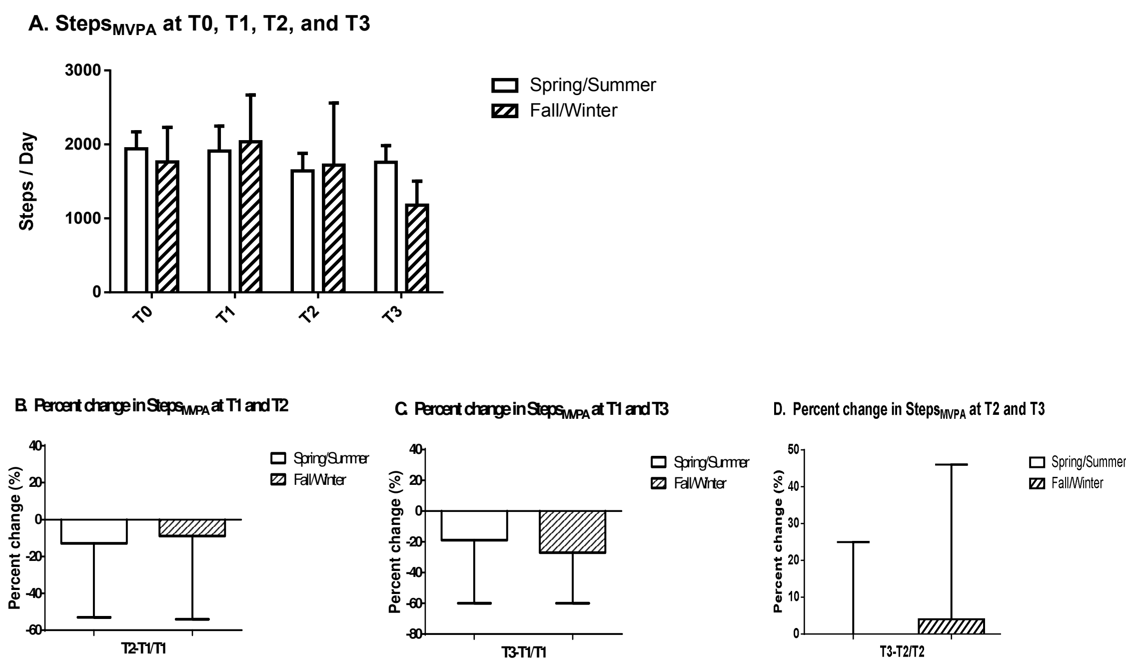
	T0	T1	T2	T3
BMI (36 kg/m^2)				
BMI_{under}	**1954 ± 323**	**1544 ± 280**	**1422 ± 324**	**1530 ± 232**
BMI_{over}	**1825 ± 273**	**2347 ± 510**	**1904 ± 468**	**1655 ± 305**
Relative Change				
T2-T1/T1				
BMI_{under}	-	-	***-12 (-56 to 32%)***	-
BMI_{over}	-	-	***-11 (-34 to 12%)***	-
T3-T1/T1				
BMI_{under}	-	-	-	***-9 (-58 to 40%)***
BMI_{over}	-	-	-	***-35 (-66 to -4%)***
T3-T2/T2				
BMI_{under}	-	-	-	***6 (-87 to 99%)***
BMI_{over}	-	-	-	***0 (-16 to 16%)***

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their BMI being under, equal to, or over the median BMI of 36 kg/m^2. BMI_{under} n=16; BMI_{over} n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity; *BMI*, body mass index.

The month the participants started the ENCOURAGE project was used to determine the seasonal category (Figure 7) the participants were involved in the Pedometer project. The two seasonal categories were Spring/Summer group (i.e. those people who enrolled in March to August) and Fall/Winter group (i.e. those people who enrolled from September to February). There were 23 participants that started in March to August

(Spring/Summer group) and 9 participants that started in September to February (Fall/Winter group). At T0, there was no difference in $Steps_{MVPA}$ between Spring/Summer group (1940 ± 232 steps) and Fall/Winter group (1761 ± 467 steps). No effect of time was observed for $Steps_{MVPA}$ in the season groups. Furthermore, no group effects were observed between season groups (Figure 7A). No significant differences were found for absolute changes in $Steps_{MVPA}$ at T1 to T2, T1 to T3 and T2 to T3 for both groups (Appendix T). Likewise, no difference in $Steps_{MVPA}$ was found between the Spring/Summer group and Fall/Winter group for relative change at T1 to T2, T1 to T3 and T2 to T3 (Figure 7B, 7C, 7D).

Figure 7: Our study population was divided into two groups based on the season they began participating in the ENCOURAGE study and we evaluated their moderate-to-vigorous (MVPA) steps per day measured using accelerometers. Values are mean ± standard error (Panel A) or median (25^{th}-75^{th} percentile; Panel C to D). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) together and separated them into two season groups (spring/summer group and fall/winter group) depending on the month they started the ENCOURAGE study. Spring/Summer (March to August) n=23; Fall/Winter (September to February) n=9. A. $Steps_{MVPA}$ at T0, T1, T2, and T3. B. Percent change in $Steps_{MVPA}$ at T1 and T2. C. Percent change in $Steps_{MVPA}$ at T1 and T3. D. Percent change in $Steps_{MVPA}$ at T2 and T3. MVPA, moderate to vigorous physical activity; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point.



Differences between the categorical MVPA steps and total steps per day data

We conducted a similar sub-analysis for the different population sub-groups for $Steps_{Total}$ (Appendix U, V, W, X, Y). The $Steps_{Total}$ data (Appendix U, V, W, X, Y) showed similar results to the $Steps_{MVPA}$ data (Appendix P, Q, R, S, T) for the gender, age, weight, BMI, and season categories. However, there was data for $Steps_{Total}$

(Appendix U, V, W, X, Y) that differed from the $Steps_{MVPA}$ data for the five categories (Appendix P, Q, R, S, T). During the analysis of the gender data, a group effect was observed where female > male ($p<0.05$) for $Steps_{MVPA}$ (Appendix P), but not for $Steps_{Total}$ (Appendix U). Furthermore, our analyses for absolute changes showed a trend at T1 to T3 between males and females for both $Steps_{MVPA}$ ($p=0.06$; Appendix P) and $Steps_{Total}$ ($p=0.08$; Appendix U). However, our analyses for relative change only showed a trend ($p=0.08$) for $Steps_{Total}$ data at T1 to T3 between females and males (Appendix U). When we analyzed the age subgroup data, we observed a group effect where $Age_{young} > Age_{old}$ ($p<0.05$; Appendix V) for $Steps_{Total}$, but not for $Steps_{MVPA}$ (Appendix Q). We continued to only see differences in our $Steps_{Total}$ data after analyzing the weight subgroup data, where a significant difference was observed for absolute change at T1 to T2 for $Steps_{Total}$ between $Weight_{under}$ (-178 ± 566 steps) and $Weight_{over}$ (-1741 ± 498 steps; $p<0.05$; Appendix W).

For the $Steps_{Total}$ data, we categorized the participants that reached 10,000 steps per day (e.g. $Steps_{10,000}$; Appendix U, V, W, X, Y). We observed no differences between the groups for the gender, age, BMI, and season categories for $Steps_{10,000}$ at any time point (Appendix, U, V, X, Y). However, there was a significant difference for $Steps_{10,000}$ in the weight category, where none of the $Weight_{under}$ (0%) group were classified as meeting the 10,000 steps per day recommendation but 31% of the $Weight_{over}$ subgroup did meet the 10,000 steps per day recommendation at T1 ($p<0.05$; Appendix W).

Chapter 4: Discussion

Overview

The purpose of the study was to help people accumulate more MVPA during walking by using a pedometer and an individualized cadenced-based exercise prescription so they could recognize, monitor, and understand when they are walking at a moderate-to-vigorous intensity. We hypothesized that the group of people who received the CBEP would increase their time spent performing MVPA to a greater extent compared to the SC group at T2 and T3, as compared to T1. Furthermore, we hypothesized that the CBEP group would show greater improvements in other objectively measured physical activity and self-reported outcomes at T2 and T3, as compared to T1.

Our results failed to support the first hypothesis because the CBEP group did not increase MVPA accumulated in 10 minute bouts ($MVPA_{10min}$) or sporadic bouts ($MVPA_{Spor}$), as compared to the SC group. Moreover, the CBEP group did not show improvements in $MVPA_{Bouts10min}$, $TotalPA_{Bouts10min}$, $TotalPA_{10min}$, $Met\text{-}min_{Total10min}$, $TotalPA_{Spor}$, $Met\text{-}min_{TotalSpor}$, $Steps_{Total}$, $Steps_{MVPA}$, $RFIT_{MVPA}$, SF-12 physical functioning, and SF-12 mental functioning, as compared to the SC group at any of the time points. We then analyzed these same variables further to assess relative changes at T1 to T2, T1 to T3, and T2 to T3 and found no difference between the groups using this additional approach. Overall, our data provides evidence that the implementation of the CBEP intervention did not have an added benefit for influencing physical activity over a 6 month time period in previously sedentary adults.

Evidence to support the feasibility of CBEP amongst previously inactive adults.

In Canada, only 15% of Canadians are meeting the CPAG aerobic exercise recommendations of 150 minutes of MVPA, performed in 10 minute bouts or longer, a week [3]. At T0, no one in our study was meeting the aerobic exercise component of the CPAG based on their $MVPA_{10min}$. One reason could be that people may not fully understand how to be active at the appropriate intensity to achieve heath benefits. Therefore, our study utilized a pedometer as a method to identify exercise intensity, since it provides instant visual feedback during walking exercise to help the user recognize their walking cadence and total step count. It is worth knowing that 65% of Canadian adults choose to walk for exercise and this type of tool may help them to optimize their walking [37]. A study conducted by Bouchard et al. [42] previously reported trends (p=0.07) that the use of a pedometer can help individuals to correctly identify exercise intensity. Therefore, we performed the current project to further explore the utility of pedometers for enhancing the time that adults spend performing MVPA.

All CBEP participants were able to reach $Cadence_{mod}$ by walking during the intervention meeting. For our CBEP participants $Cadence_{mod}$ was 126 ± 2 steps per minute. These results differ from previous studies [39, 41] that reported that 95 to 110 steps per minute was the minimum threshold for walking at a moderate intensity. The prescribed cadence in the current study may be higher because we prescribed the cadence to match 50% HRR rather than the minimum threshold for moderate intensity at 40% HRR. We decided to prescribe the cadence at 50% of HRR because it is the middle point of the heart rate zone for moderate intensity exercise (40%-59% of HRR) [62]. The fact that all the CBEP participants were able to achieve $Cadence_{mod}$ supports our decision to use 50% of HRR to prescribe cadence. The CBEP participants reported a Borg Scale rating of 4 ± 0.4 at $Cadence_{mod}$. A rating of 4 to 6 represented moderate intensity [65]. Therefore, the CBEP participants perceived that they were walking at a moderate intensity when they reached their target HR at 50% HRR.

During the five minute walk that was used to assess the CBEP participants perception of $Cadence_{mod}$, we found the difference between the prescribed steps (632 ± 9) and actual steps (616 ± 13) taken over the 5 minutes was 17 ± 9 steps (i.e. 3 ± 2 steps/minute). This shows that the CBEP participants were able to achieve the prescribed cadence for a five minute walk based on their perception of $Cadence_{mod}$. An increase of only about 3-4 steps per minute would have been needed to walk at a moderate intensity for the full 5 minutes. Therefore, our data shows that the CBEP intervention is feasible to apply to our inactive population because they could physically reach and perceive moderate intensity during walking exercise. This notion is supported by the information from the follow-ups to the intervention meetings that showed CBEP increased the motivation of the participants to participate in more physical activity. All of the CBEP participants liked the new method for tracking exercise intensity using the pedometer at 2 week follow-up. Fifty-three percent and seventy-four percent of the CBEP participants felt motivated to do more physical activity at 2 week follow-up because of the cadenced-based prescription and intervention (i.e. meeting itself), respectively. All participants, except one of the CBEP participants found the intervention meeting helpful at 2 week follow-up. These data showed that participants perceived CBEP in a positive way and as a motivator for them to become more physically active.

CBEP participants have an increased risk of morality based on their maximum oxygen consumption (VO_{2max})

Cardiorespiratory fitness is an important prognostic factor for all-cause mortality in healthy adults [19, 20]. Specifically, Mandic et al. [19] found that people in the quintile with the lowest VO_{2max} (15.4 ± 3.5 ml/kg/min) had a four-fold increased risk for cardiac events and all-cause mortality as compared to the people in the quintile with the highest VO_{2max} (50.4 ± 6.7 ml/kg/min). Furthermore, the relative risk of mortality was shown to be two times greater for people in the lowest VO_{2max} (15.4 ± 3.5 ml/kg/min) quintile compared to the next lowest VO_{2max} (23.8 ± 1.8 ml/kg/min) quintile for cardiorespiratory fitness [19]. We conducted the 6MWT with our CBEP participants and calculated their VO_{2Max} (ml/kg/min) using *Equation 5* [94] and found a VO_{2Max} of 24 ± 1 ml/kg/min. Based on the evidence reported by Mandic et al. [19], the CBEP participants were in the next lowest VO_{2max} (23.8 ± 1.8 ml/kg/min) quintile for cardiorespiratory fitness. The next lowest VO_{2max} (23.8 ± 1.8 ml/kg/min) quintile was shown to have two times the relative risk of mortality as compared to people in the highest VO_{2max} (50.4 ± 6.7 ml/kg/min) quintile for cardiorespiratory fitness. In addition, a VO_{2Max} of 24 ± 1 ml/kg/min is considered as a poor VO_{2Max} [61] for healthy subjects of all age groups. These results may be affected because *Equation 5* [94] is only applicable to participants between the ages of 26 to 60, while our study population was between the ages of 25 to 75. We decided to look into it further and compared baseline characteristics between our CBEP participants and the specific quintile groups they matched up with in the Mandic et al. [19] study. Our CBEP (50 (42 to 58) years) participants were younger in age as compared to Mandic et al. [19] participants in that quintile (60 ± 10 years). This means that our CBEP population is probably at an increased risk for all-cause mortality and cardiovascular events at a younger age. The difference in gender between the groups was staggering, our CBEP participants were mostly females (68%), while the Mandic et al. [19] quintile showed only 7% were female. This could be a reason for our CBEP population having a lower VO_{2max} at a younger age, since females tend to have a lower VO_{2max} as compared to males. When BMI was assessed, we observed that the CBEP population had a higher BMI (39 ± 1 kg/m^2) as compared to the Mandic et al. [19] quintile (29.5 ±5.5 kg/m^2). This is important because it shows the CBEP population was overweight or obese, while the Mandic et al. [19] quintile had about 40% of their participants being obese. Obesity is a major risk factor for developing other chronic diseases, such as Type 2 Diabetes, cardiovascular disease, and more [61]. We did find that the CBEP participants 6MWT results (554 ± 14 metres) is similar to the 6MWT distances data shown in Casanova et al. [102] study that showed distances that ranged between 510 to 638 metres over 7 different countries. However, we were unable to compare the VO_{2Max} of SC and CBEP because we did not complete the 6MWT with the SC group. Therefore, we were not able to calculate the VO_{2Max} and measure the walking distance that would have been completed during the 6MWT in the SC group. On the other hand, none of the baseline characteristics, accelerometer parameters, and self-reported parameters differed between SC and CBEP at any of the time points. These data suggest that our SC population was as inactive as our CBEP population and that both experimental groups were prime targets to receive the CBEP intervention to help them achieve health benefits.

Measured cadence was similar between Garmin FR60 and accelerometry.

Strong correlations ($r=0.85$, $p<0.01$ & $r=0.87$, $p<0.01$) have been shown between accelerometer and pedometer determined steps per day [98]. However, it is not understood how similar cadence measured by the Garmin FR60 and Actical accelerometer are. Therefore, we examined how similar the measures at $Cadence_{mod}$ were between the Garmin FR60 and Actical accelerometer. We were only able to compare data for two participants because we made this decision to examine $Cadence_{mod}$ between the two devices near the end of our recruitment phase. Our data showed that there was only a difference of 1-2 steps at $Cadence_{mod}$ between the cadence measured by the Garmin FR60 foot pod worn on the foot and Actical accelerometer worn on the hip for the two participants. These data indicate that the Garmin FR60 was an appropriate device to use to measure $Cadence_{mod}$. In addition, the data supports the Actical accelerometer cut-points utilized to identify $Steps_{MVPA}$ was appropriate to use for our study population. Therefore, our individualized CBEP was considered to be accurate for prescribing the number of steps needed to reach moderate intensity at 50% HRR.

CBEP maintained physical activity over time in participants.

Pedometer interventions have been shown to be effective for increasing physical activity levels of sedentary adults [68]. Specifically, the pedometer interventions that used a step-based goal was shown to predict increased physical activity levels ($p<0.001$) [68]. Bouchard et al. [42] showed the trend ($p=0.07$) in using pedometers to correctly identify exercise intensity. Therefore, we believed that the CBEP intervention would increase participant's physical activity levels. However, our results indicate that CBEP did not influence physical activity accumulated in 10 minute bouts (e.g., TotalPA_{10min}, MVPA_{10min}). Based on our MVPA_{10min} data, we found that none of our participants were meeting the aerobic exercise component of the CPAG at T0. This means our study population were similar to the 85% of Canadians that do not meet the aerobic exercise recommendations in the CPAG [3]. Our MVPA_{10min} data at T0 for SC (21 ± 12 min/week) and CBEP (22 ± 8 min/week) was less than the MVPA_{Spor} that an obese population accumulates (49 min/week) [103]. Furthermore, there was no difference between SC and CBEP at any time point when we assessed $\text{MVPA}_{AE\text{-}CPAG}$. In addition, the MVPA_{10min} data from the current study are similar to Marshall et al. [56], which showed no difference in MVPA_{10min} between step-based goals over a 12 week period. However, our $\text{MVPA}_{Bouts10min}$ at the completion of the intervention (e.g. T2) for SC (0.1 ± 0.1 bouts/day) and CBEP (0.2 ± 0.1 bouts/day) was less than the $\text{MVPA}_{Bouts10min}$ data in Marshall et al. [56] (1.25 bouts/day). We interpret these results as an indication that CBEP does not alter physical activity performed in 10 minute bouts. Even so, the CBEP intervention increased the self-reported motivation of the participants to be more physically active based on the information they provided from the follow-up meetings. Therefore, it appears that CBEP may be a strategy to help motivate participants to become more physically active, but the increased motivation may not translate into a change in physical activity behaviour.

Recent literature has reported health benefits based on the accumulation of MVPA_{Spor} (e.g., in bouts of 30 seconds or longer) [104-106]. Specifically, McGuire et al. [105] found a significant association between MVPA_{Spor} and cardiorespiratory fitness (r=0.45) in obese adults. In addition, MVPA_{Spor} was shown as an independent predictor of cardiorespiratory fitness after controlling for age, BMI and intensity of physical activity [105]. There is also evidence showing that an increase of $MVPA_{Spor}$ by 10 minutes per day can reduce the prevalence of obesity by 15% [104] and a 15 minute per day increase of $MVPA_{Spor}$ can reduce all-cause mortality by 4% (95% CI 2·5–7·0) [106]. However, our data failed to show that CBEP participants increased their $MVPA_{Spor}$ and $Total_{Spor}$ at any time. We compared our $MVPA_{Spor}$ data to the Wen et al. [106] study that evaluated the health benefits, mortality, and life expectancy of accumulating different volumes of physical activity in a large Taiwanese cohort. When compared to data from Wen et al. [106], both groups in the current study would be placed in the low-volume activity group because they are accumulating at least 90 minutes per week or 15 minutes a day of $MVPA_{Spor}$. Theoretically, the participants in the current study have a 14% reduced risk of all-cause mortality as compared to individuals who perform less physical activity [106]. Furthermore, our $MVPA_{Spor}$ data at T0 for SC (124 ± 21 min/week) and CBEP (139 ± 19 min/week) was similar to the $MVPA_{Spor}$ that an obese population accumulates (126 min/week) [103]. However, it is unclear if the lack of change in $MVPA_{Spor}$ can be explained by the population characteristics in our cohort.

It has been shown in the literature that achieving 10,000 steps per day can help people meet physical activity guidelines and obtain health benefits [107, 108]. Specifically, a study by Le Masurier et al. [108] demonstrated that a greater proportion of people that did 10,000 steps or more met the physical activity guidelines of performing 30 minutes of moderate physical activity a day, as compared to people that did less than 10,000 steps per day. In addition, Iwane et al. [107] showed that walking 10,000 steps per day or more reduced blood pressure and sympathetic nerve activity and increased exercise capacity in hypertensive patients. Even so, only 35% of Canadians are reaching 10,000 steps per day [3]. This proportion, however, is a higher percentage than the 15% of Canadians meeting the CPAG recommended aerobic exercise [3]. One reason for this discrepancy could be that people accumulate more of their $Steps_{Total}$ at a light intensity. Notably, one recent study by McClain et al. [99] validated the reliability of the $Steps_{MVPA}$ measurement using accelerometers in an adult population. Their results provided verification that Actigraph accelerometers are reliable and accurate at measuring both steps and activity counts by comparing the data from accelerometers worn on the right and left hip over a 24 hour period [99]. To our knowledge, no one has evaluated $Steps_{MVPA}$ since McClain et al. [99] published their validity data. Therefore, we are the first to report $Steps_{MVPA}$ from an interventional trial. Our Steps (i.e. $Steps_{MVPA}$ and $Steps_{Total}$) data showed that $Steps_{Total}$ and $Steps_{MVPA}$ did not change over time between SC and CBEP. Based on $Steps_{Total}$, only 7% and 6% of the participants were meeting $Steps_{10,000}$ in SC and CBEP at T0, respectively. Although participants reported that CBEP helped them to increase their motivation to become more active, the accelerometer parameters analyzed did not support the notion that the CBEP intervention was better than SC.

A seasonal effect was not seen for total and MVPA steps per day.

Seasonal effects have been shown in literature to have an effect on physical activity levels [109-116]. Specifically, people tend to be more active and take more steps in the summer than in the winter [109-116]. Based on the study conducted by Merchant et al. [117] , 64% of Canadians are known to be inactive in the winter as compared to 49% in the summer [117]. In addition, the number of people participating in a physical activity bout of at least 15 minutes was 48% higher in the summer than in the winter [117]. Specifically in Manitoba, the number of people participating in physical activity bouts lasting at least 15 minutes was higher in the spring (+24%), summer (+40%), and fall (+17%), as compared to winter [117]. However, there is no study showing the impact of seasonal effects on $Steps_{MVPA}$ in any population. Our subgroup analysis of $Steps_{Total}$ ($Steps_{Total}$ at T0; Spring/Summer group, 6354 ± 542; Fall/Winter, 5511 ± 795; Appendix Y) and $Steps_{MVPA}$ ($Steps_{MVPA}$ at T0; Spring/Summer group, 1940 ± 232; Fall/Winter, 1761 ± 467; Appendix T) analyzed using a two-way ANOVA failed to detect a difference between the Spring/Summer group and Fall/Winter group. The observed results demonstrate that there was no seasonal effect on participants $Steps_{Total}$ and $Steps_{MVPA}$ over a 6 month period. This outcome differs from Dasgupta et al. [112] who reported a seasonal effect amongst a cohort of Type 2 diabetic patients, where they had daily step levels of 5659 ± 2611 steps/day in Spring/Summer that were even lower in the Fall/Winter (4901 ± 2464 steps/day). We also performed a three-way ANOVA for $Steps_{Total}$ and $Steps_{MVPA}$ where time (T0, T1, T2, and T3) was a repeated measure and the experimental groups (group [SC or CBEP] and season [Spring/Summer or Fall/Winter]) were between group comparisons. This 3-way ANOVA approach did not identify any effect for group, time, or season (Appendix Z). Overall, our various season analyses indicated that both season groups maintained $Steps_{Total}$ and $Steps_{MVPA}$ over time.

Literature has shown that season changes occur in physical activity levels [109-116], but a season change did not occur in the current study. Moreover, $Steps_{MVPA}$ was not different between any of the season subgroups, but it is important for us to point out that the sample size of the Spring/Summer group was 23; whereas, 9 participants were in the Fall/Winter group. This sample size issue could be the reason why the $Steps_{MVPA}$ at T3 between Spring/Summer group (1755 ± 228 steps/day) and Fall/Winter group (1178 ± 325 steps/day; Appendix T) was not statistically significant. If there were no sample size issue, then the $Steps_{MVPA}$ results may have shown a difference between Spring/Summer group and Fall/Winter group at T3. In addition, the same sample size issue could have affected $Steps_{MVPA}$ between Spring/Summer group and Fall/Winter group at T0, T1, and T2 as well. However, we are aware that a season change may not have appeared for $Steps_{MVPA}$ at T0 (Spring/Summer, 1940 ± 232 steps/day; Fall/Winter, 1761 ± 467 steps/day), T1 (Spring/Summer, 1911 ± 336 steps/day; Fall/Winter, 2033 ± 635 steps/day), and T2 (Spring/Summer, 1642 ± 236 steps/day; Fall/Winter, 1718 ± 843) because the participants in the Fall/Winter group were attending physical activity counselling sessions with a CSEP-CEP. The normal decrease in physical activity that we should have seen in the participants in the Fall/Winter groups could have been influenced by the CSEP-CEP physical activity counselling sessions. So it could be that the participants in the Fall/Winter group were more active at T0, T1, and T2 then they would normally have been without the physical activity counselling sessions. Furthermore, the mean difference in the number of $Steps_{MVPA}$ between the Spring/Summer group and Fall/Winter group was the biggest when the participants were no longer attending physical activity counselling sessions at T3. On the other hand, it appears that the Spring/Summer group was able to maintain their $Steps_{MVPA}$ over the 6 month period. Based on this data, it appears that the CSEP-CEP physical activity counselling sessions over the four month period may have been an intervention in itself and may have been able to delay the onset of a seasonal effect in our data at T0, T1, and T2. However, our results were not able to statistically verify if the delayed onset of a seasonal effect did occur in our data due to our sample size difference between the Spring/Summer group and Fall/Winter group.

Total steps and steps performed at a moderate-to-vigorous intensity were not affected by the baseline characteristics of the participants in our study population.

Our study population was recruited from the ENCOURAGE study, which offered all participants physical activity counselling from a CSEP-CEP in a primary care setting and referrals to physical activity programs in the community. Evidence in scientific literature has shown that strategies to increase physical activity interventions integrated into primary care can increase self-report physical activity [36, 55, 78]. However, Fortier et al. [55] showed no increase in minutes of MVPA per day measured by accelerometer after implementing a physical activity counsellor into primary care. Our results measured by accelerometer showed similar results to the Fortier et al. [55] study with no increase in $MVPA_{10min}$ or $MVPA_{Spor}$ over time between experimental groups. Moreover, our $Steps_{Total}$ and $Steps_{MVPA}$ data showed no difference between CBEP and SC at any time point. Furthermore, we conducted several sub-analyses with our entire study population pooled together since all participants received physical activity counselling from the CSEP-CEP for $Steps_{Total}$ (Appendix U, V, W, X, Y) and $Steps_{MVPA}$ (Appendix P, Q, R, S, T) based on the median baseline characteristics of Gender, Age, Weight, BMI and Season, as discussed below.

A systematic review evaluating the effectiveness of pedometer interventions for increasing physical activity in sedentary adults conducted by Bravata et al. [68] had 85% of their population being female. Our sub-analysis for gender was similar with about 69% of our population being female. In Canada, males (9,500 steps per day) accumulate more steps then females (8,400 steps per day) [3]. Our $Steps_{Total}$ data showed that males accumulated 6500 ± 1018 steps per day and females accumulated 5942 ± 473 steps per day at T0 (Appendix U). However, our $Steps_{MVPA}$ data showed a group effect ($p<0.05$), where females were more active and accumulated more $Steps_{MVPA}$ than males. The group effect was not observed in the $Steps_{Total}$ data (Appendix U). At T0, females accumulated 2199 ± 255 $Steps_{MVPA}$, while males did only 1209 ± 264 $Steps_{MVPA}$. These results show that although males and females accumulate similar $Steps_{Total}$, females tend to accumulate more of their steps at a moderate-to-vigorous intensity than males. The difference in results could be due to our sample size (n=32) being smaller than that assessed by Colley et al. [3] (n=2,832). Additionally, the fact that our sample was recruited from a primary care setting rather than the broader Canadian population could account for the difference in results [3]. Furthermore, our study population had a median BMI of 36 kg/m^2, with more than half of the participants being classified as obese, which may contribute to the different results from those of Colley et al. [3].

Literature has shown that adults (20 to 65 years) take more total steps per day than adults older than 65 years [118, 119]. In Canada, adults that are 20 to 59 years of age average 9,369 steps per day, while those that are 60 to 79 years of age average 7,420 steps per day [3]. Our $Steps_{Total}$ results showed that Age_{young} (e.g., below or equal to 52 years) accumulated 7187 ± 637 steps per day and Age_{old} (e.g., above 52 years) accumulated 5046 ± 519 steps per day at T0 (Appendix V). Furthermore, our $Steps_{Total}$

data (Appendix V) showed a group effect ($p<0.05$), where Age_{young} were more active and accumulated more $Steps_{Total}$ than Age_{old}. The group effect was not observed in the $Steps_{MVPA}$ data. At T0, Age_{young} performed 2185 ± 244 $Steps_{MVPA}$, while Age_{old} did 1593 ± 330 $Steps_{MVPA}$. These results show that Age_{young} take more $Steps_{Total}$ compared to Age_{old}, but both groups are able to maintain the number of daily steps they take at a moderate-to-vigorous intensity. A limitation could have been that we separated our groups based on the median to have equal sample sizes in both age groups, rather than following the ages for CPAG [9, 10]. However, this would not be feasible because we only had one participant that was 65 years or older.

In Canada, overweight or obese individuals take fewer steps per day (8,471 steps per day) than healthy adults (9698 steps per day) based on BMI classifications [3]. The median BMI of 36 kg/m^2 of our study population showed that more than half of the participants were classified as obese. This is an alarming statistic because a high proportion of participants were at risk for developing chronic diseases, such as Type 2 Diabetes, cardiovascular disease, and more [61]. Our $Steps_{Total}$ results showed that BMI_{under} (e.g., BMI under or equal to 36 kg/m^2) accumulated 6103 ± 684 steps per day and BMI_{over} (BMI over 36 kg/m^2) accumulated 6131 ± 600 steps per day at T0 (Appendix X). Even so, our $Steps_{Total}$ (Appendix X) and $Steps_{MVPA}$ results did not show a difference between BMI_{under} and BMI_{over} at any time points. At T0, BMI_{under} took 1954 ± 323 $Steps_{MVPA}$, while BMI_{over} did 1825 ± 273 $Steps_{MVPA}$. Similar results were observed for $Steps_{Total}$ (Appendix W) and $Steps_{MVPA}$ in the groups $Weight_{under}$ (e.g., weight under or equal to 103 kg) and $Weight_{over}$ (weight over 103 kg). At T0, $Weight_{under}$ accumulated 6089 ± 667 steps per day, while $Weight_{over}$ took 6144 ± 619 steps per day (Appendix

W). Furthermore, $Weight_{under}$ accumulated 2080 ± 355 $Steps_{MVPA}$, while $Weight_{over}$ took 1699 ± 221 $Steps_{MVPA}$ at T0. The results may have shown a difference in $Steps_{Total}$ and $Steps_{MVPA}$ between the BMI and weight groups if we separated our groups based on ranges with specific cut-offs for classifications (e.g., BMI index), rather than the median. However, our small sample size prevented such an analysis.

Overall, the baseline characteristics of our study population did not affect the $Steps_{Total}$ and $Steps_{MVPA}$ that our participants performed over time. These results support the $Steps_{Total}$ and $Steps_{MVPA}$ data between CBEP and SC that show $Steps_{Total}$ and $Steps_{MVPA}$ does not change over time. Furthermore, our data provides novel baseline $Steps_{MVPA}$ data for an obese and previously inactive adult population. Our $Steps_{MVPA}$ data can be used as a stepping stone for future research since no studies have evaluated $Steps_{MVPA}$ for interventions involving physical activity counselling led by a CSEP-CEP in primary care or for interventions that have utilized pedometers as a tool to promote physical activity.

Using CBEP does not enhance the quality of life of participants

The impact of integrating a physical activity counsellor into primary care may not influence quality of life [55]. However, the literature has indicated that people with or without chronic conditions who increase their physical activity levels improve their quality of life [120-122]. For example, evidence from Ewald et al. [123] shows a relationship between pedometer use and improved quality of life in general health as steps per day increases [123]. Furthermore, Kolt et al. [78] found significant improvements over time in quality of life for general health, vitality, physical functioning, and mental health in its pedometer group. There are few data indicating the effectiveness of a CBEP on parameters of quality of life amongst inactive adults. Our study failed to show that CBEP enhances the physical and mental functioning components of the SF-12 quality of life questionnaire over time, as compared to SC. This outcome may have been influenced by the fact that our participants did not increase their physical activity levels above baseline levels. Our SF-12 mental functioning data contrasts that of Kolt et al. [78], where they reported that participants in both of their experimental groups improved mental health over time. Our data could have differed from the Kolt et al. [78] study because they had a larger sample size in their study (i.e. n=330), as compared to our smaller sample size.

Limitations

Our study did have limitations that we will address. First, our sample size may not have been large enough to detect differences in change in $MVPA_{10min}$ measured by accelerometers. In addition, we did not detect differences in the additional outcome measures. However, trends towards significance were detected for relative change between different time points for other variables (e.g., SF-12 physical functioning) in CBEP, as compared to SC. These data make it difficult for future research involving pedometer interventions to conduct sample size calculations and power analyses.

With regards to our study population, we are aware that a selection bias could have occurred with having 9 people decline to being in the CBEP group and consenting to be in the SC group. There results could be affecting our data because they chose to be in the SC group and may account for no differences being seen in any of the accelerometer parameters. However, the 9 people that declined to being in the CBEP group did use pedometers, received the standard care intervention, and completed all the data collection meetings, which was the reason why we included them in the SC group.

Our baseline characteristic data showed that there was no significant difference between SC and CBEP for weight; however, CBEP was about 8 kg heavier than SC. This limitation could be important because literature has shown normal weight adults (18.5 to 24.9 kg/m^2) do more physical activity than overweight (25.0 to 29.9 kg/m^2) and obese adults (30.0 kg/m^2 or more) [3, 111]. However, both SC (36 ± 1 kg/m^2) and CBEP (39 ± 1 kg/m^2) had similar BMI's that would classify them both as a class II obese population [61]. Moreover, our sub-analysis based on weight (i.e. $Weight_{under}$ and $Weight_{over}$) and BMI (i.e. BMI_{under} and BMI_{over}) indicated that there was no difference in $Steps_{Total}$ (Appendix W, X) and $Steps_{MVPA}$ between the experimental groups at any time points. However, we did observe a significant difference for absolute change at T1 to T2 for $Steps_{Total}$ between $Weight_{under}$ (-178 ± 566 steps) and $Weight_{over}$ (-1741 ± 498 steps; $p<0.05$; Appendix W). In addition, there was a significant difference for $Steps_{10,000}$ in the weight category, where none of the $Weight_{under}$ (0%) group were classified as meeting the 10,000 steps per day recommendation but 31% of the $Weight_{over}$ subgroup did meet the 10,000 steps per day recommendation at T1 ($p<0.05$; Appendix W). These results differ from Colley et al. [3] that show Canadians with higher BMI's do less physical activity than those with lower BMI's. One reason why more participants in the $Weight_{over}$ group were reaching the 10,000 steps per day recommendation than the $Weight_{under}$ group at T1 could be the fact that 11 out of the 16 participants in the $Weight_{over}$ group were in the CBEP group (data not shown). The increased self-reported motivation of the CBEP participants to be more physical active could account for this observation. However, the difference was observed at T1, which was before the implementation of the CBEP intervention. Therefore, CBEP was not the reason why more participants in the $Weight_{over}$ group were reaching the 10,000 steps per day recommendation than the $Weight_{under}$ group. We did consider, however, that a higher BMI and an increase in steps would increase the work of moving. This lead to our analysis between SC and CBEP and the weight sub-groups to evaluate the work of moving (i.e. BMI_{Steps}) by multiplying BMI and $Steps_{Total}$ (i.e. kg/m^2 * $Steps_{Total}$; Appendix X). During the SC and CBEP analysis, we found no group, time, and interaction effect for BMI_{Steps} (Appendix X). However, when we analyzed the weight sub-groups, we found a group effect for BMI_{Steps}, where $BMI_{under} < BMI_{over}$ ($p<0.05$; Appendix X). Therefore, our results indicated that the participants in the BMI_{over} group did more BMI_{Steps} as compared to the BMI_{under} group. On the other hand, $Steps_{Total}$ in the BMI sub-groups in Table 14 indicated that there was no difference between the groups at any time point. This means that the group effect seen in BMI_{Steps} is because of the higher BMI in the BMI_{over} group and not from an increase in $Steps_{Total.}$

There are several personal characteristics that we did not address during our data collection that could have affected our outcomes. For example, we could have collected information about sleeping behaviour, eating behaviour, and calcium consumption in our population because these factors have been linked to influence weight gain and the development of obesity [124]. Furthermore, we could have assessed psychological characteristics that could have affected the outcomes in our study that were collected in the ENCOURAGE study, but not utilized in this project. For example, we could have utilized the stage of behavioural change [89] data at each time point to see if participant subgroups changed their physical activity behaviour to a greater extent in CBEP, as compared to SC. However, our sample size was too small to support such an approach.

Another limitation to our study was that we could not verify if participants were using the CBEP approach properly. We could have asked the participants to chart their steps during walking exercise and to provide us with their charts at their T2 and T3 follow-up appointments. Furthermore, we could have tested them with a 5 minute walk at T2 and T3 to evaluate if they were using CBEP properly and to compare their 5 minute walk results at T1, T2, and T3. We could have also utilized the Walk4life MVPA pedometers to better support participants so they would utilize the CBEP approach more effectively, as discussed in a later section of the document. However, to the best of knowledge, Walk4life MVPA pedometers were not available when this project was implemented.

Certain aspects of our methods could have affected our outcomes as well. One limitation was the research staff was not blinded to the participants in SC and CBEP. Additionally, a better tool to support the CBEP intervention would have been to use Walk4life MVPA pedometers [125]. The Walk4life MVPA pedometers can set cadence thresholds and can monitor participant's steps and time above and below the threshold [125]. Using the Walk4life MVPA pedometers would allow us to design the CBEP to recommend the participant to walk above the cadence threshold continuously for a specified time. The monitoring aspect of CBEP would have been a lot easier for the participants to utilize than the approach utilized in this study.

All of the participants in both the SC and CBEP groups used pedometers. This fact could be a limitation in the current study because it has been shown that the use of pedometers are effective for increasing physical activity levels of sedentary adults [68, 76-78]. Therefore, we could have designed the study to include a group that did not utilize pedometers at all and then compare that group to both the SC and CBEP groups. However, given the fact that we designed this study to determine if CBEP was better than SC, we did not include the no pedometer reference group in our original design.

In fact, all of the participants in both the SC and CBEP group were advised to accumulate 10,000 steps per day as a step goal by the CSEP-CEP during his physical activity counselling sessions. This could be a limitation because it has been shown that having any step based goal was a significant predictor of increased physical activity ($p<0.0001$) [68]. Therefore, the participants in the SC group could have maintained their physical activity levels because they had a step based goal of 10,000 steps per day to follow. In addition, the participants in the CBEP group may not have increased their physical activity because they could have been confused with using the 10,000 steps per day goal and CBEP goal. One reason why they were confused between the two step goals is because 58% and 63% of the CBEP participants indicated that they wore the pedometer all day at the 2 and 6 week follow-up phone calls for the CBEP intervention meeting, respectively. This may account for no differences being seen in any of the accelerometer parameters. Moving forward, future pedometer interventions using CBEP may show differences in accelerometer parameters if the CBEP group received the cadenced-based step goals, while the SC group did not receive any step-based goals.

Actigraph accelerometers are reliable and accurate at measuring both steps and activity counts [99]. However, the way that the Actigraph accelerometers are programmed to collect data influences how that data is interpreted. In this study, we programmed the accelerometers to measure physical activity in 30 second intervals. It is possible that participants were accumulating their MVPA in bouts less than 30 seconds, which may have limited our analysis because $MVPA_{Spor}$ activity was measured in bouts lasting 30 seconds or longer. In fact, published literature has reported that $MVPA_{Spor}$ was significantly higher when measured using shorter intervals (i.e. 5 and 10 second intervals), as compared $MVPA_{Spor}$ measured using longer intervals (i.e. 1 minute intervals) in adults and children [126, 127]. Specifically, the Gabriel et al. [103] study compared 60 second and 10 second intervals in post-menopausal women and found that $MVPA_{Spor}$ was significantly higher using 10 second intervals (42.4 ± 22.4 minutes/day) compared to 60 second intervals (26.9 ± 20.1 minutes per day; $p<0.001$). Therefore, we could have analyzed our accelerometer data in 1, 2, 4, 5, or 10 second intervals rather than 30 second intervals to determine if more $MVPA_{Spor}$ and $Steps_{MVPA}$ were being accumulated in bouts less than 30 seconds. Shorter intervals would have provided us with more specific information on the participant's physical activity levels and behaviour. However, we needed to collect data for at least 7 days, so we used 30 second intervals because our accelerometers had limited capacity and intervals that were 15 seconds or shorter could not collect data for 7 days.

A limitation that could have affected our results was that our inclusion for our accelerometer analysis was 3 valid accelerometer days or more, rather than the recommended 4 valid accelerometer days or more [3, 97]. However, our analysis of the number of valid accelerometer days at each time point (Appendix AA) showed that participants in both SC and CBEP were completing between 5-7 valid accelerometer days at each time point. Specifically, there was a group effect for the number of valid accelerometer days, where CBEP > SC ($p<0.05$; Appendix AA). Furthermore, a time effect for the number of valid accelerometer days was observed, where T0, T1 > T2, T3 ($p<0.05$; Appendix AA). Based on these results, the CBEP group was more likely to complete more valid accelerometer days as compared to the SC group. Moreover, these results show that participants in both SC and CBEP wore the accelerometers for 4 or more valid days.

Another limitation was that we analyzed accelerometer data using 8 hours or more of wear time to define a valid accelerometer day, rather than the recommended 10 hours or more of wear time [3, 103, 128]. However, a study conducted by Jerome et al. [103] showed that minimum wear times of 6 and 10 hours per day yielded similar results in an obese population for $MVPA_{Spor}$ (18.0 an 18.3 minutes per day) and $MVPA_{10min}$ (6.7 and 6.9 minutes per day). Therefore, the use of a shorter wear time to define a valid accelerometer day was feasible to use for our obese population. In addition, we decided to analyze the length of wear times of valid accelerometer days that participants in SC and CBEP were completing (Appendix AA). Our results showed that at T0, the length of wear time for SC (12.4 ± 0.4 hours/day) and CBEP (13.1 ± 0.3 hours/day) was less than the wear time the average Canadian completes (14.0 hours/day) [3]. However, our results show that both SC and CBEP completed about 12 hours per day of wear time on a valid accelerometer day at each time point, which is higher than the recommended 10 hours or more of wear time per day [3]. The limitation of using 8 hours or more of wear time to define a valid accelerometer day would therefore have little effect on our accelerometer analyses.

The strategy that we utilized to analyse accelerometer data was to use standard cut-points to measure physical activity performed at a moderate intensity. People reach moderate physical activity at different cadences, so they should have different cut-points thresholds for measuring moderate physical activity using accelerometers. Therefore, we conducted a sub-analysis of our accelerometer data to compare the 17 CBEP participants' physical activity (i.e. $TotalPA_{10min,}$ $MVPA_{10min}$, $TotalPA_{Spor}$ $MVPA_{Spor}$, $Steps_{Total}$, and $Steps_{MVPA}$) using standard and individualized cut-points, as described in Appendix BB. The standard cut-point threshold we used for moderate physical activity was 768 counts. In contrast, we calculated the individualized cut-point threshold for moderate physical activity for each CBEP participants and used it to analyze their accelerometer data. To calculate their individualized cut-point threshold for moderate physical activity, we divided their specific $Cadence_{mod}$ measured by the Garmin FR60 device during the 6MWT by the average $Cadence_{mod}$ (126 ± 2 steps/minute) of the CBEP group and then multiplied that proportion by the standard cut-point of 768 counts for moderate physical activity. The average individualized cut-point for moderate physical activity was 773 ± 12 counts (data not shown). The results showed that there was no difference between the CBEP groups' accelerometer data analyzed using standard cut-points and individualized cut-points for physical activity (i.e. $TotalPA_{10min,}$ $MVPA_{10min}$, $TotalPA_{Spor}$ $MVPA_{Spor}$, $Steps_{Total}$, and $Steps_{MVPA}$; Appendix BB). It would have been beneficial if we could have compared the physical activity data analyzed using individualized cut-points between CBEP and SC. Unfortunately, we could not individualize the cut-points for the SC group because they did not complete the 6MWT and their $Cadence_{mod}$ was not obtained in the current study.

It is difficult to determine if the increase in self-reported motivation to participate in more physical activity was because of CBEP or the extra attention/intervention meeting given additionally with the physical activity counselling sessions. However, our follow-ups at two weeks after the CBEP intervention meetings indicate that it was both CBEP (53%) and the extra attention/intervention meeting (74%) that increased their motivation to be more physically active. Therefore, future pedometer interventions using CBEP should include more CBEP coaching completed in-person or over the phone, since the extra attention from the additional intervention meeting increased self-reported motivation of the participants to participate in more physical activity.

A limitation of the CBEP intervention could be the feasibility of its implementation into a clinical setting. During the current study, we booked the CBEP intervention meetings for 60 minutes at the participant's preferred location where it was possible to walk for 30 consecutive minutes. In fact, the CBEP intervention meetings only took about 30 minutes to complete (data not shown). However, it is not feasible for a general practitioner to leave the clinic and perform the CBEP intervention meeting for 30 minutes and then return to the clinic. That method would not allow enough time for the general practitioner to assess the patient's needs for their visit. Therefore, it would be beneficial if the CBEP intervention meeting could be completed within 5 minutes. In addition, Swinburn et al. [36] showed that 5 minutes of verbal advice and written exercise prescription to increase physical activity levels from a general practitioner increases physical activity levels of inactive adults. One way to perform the CBEP intervention meeting in 5 minutes would require calculating the participant's target heart rate to reach 50% of HRR using *Equation 2, Equation 3, and Equation 4* (*n.b.; found in the*

Heart Rate Monitor section of the document). The next step would include having the participant's wear the Garmin FR60 device. The general practitioner would then go for a walk down the hall with the participant and instructing them to walk as quickly as possible. The participant's cadence can be recorded when they reach their target HR at 50% of HRR ($Cadence_{mod}$). The general practitioner can then fill in the CBEP sheet for the participant to take home to monitor their intensity during walking exercise in their own environment using a pedometer. However, the general practitioner can instruct the participants who do not have a pedometer to remember how they felt when they reached their $Cadence_{mod}$ and to try feeling that way every time they walk for exercise. There would be no additional follow-up calls needed specifically for the CBEP intervention. The general practitioner could follow-up about CBEP during the participant's general follow-up phone calls or appointments. On the other hand, another way we could implement the CBEP intervention in 5 minutes or less would require conducting a future research study to create an algorithm to use to reduce the CBEP intervention calculations to something that would take 30 seconds or less, but that would be accurate for a variety of participant characteristics (i.e. ages, fitness levels, etc). Then the generally practitioner could provide a brief 3 minute instruction and demonstration on how to walk at that cadence using a pedometer. This would provide an easier method to implement the CBEP intervention and optimize the general practitioner's time during the participant appointments.

Summary

Our data demonstrate that CBEP does not increase $MVPA_{10min}$ to a greater extent, as compared to SC. Moreover, our accelerometer parameters showed no differences between SC and CBEP at T0, T1, T2, and T3. However, the CBEP intervention was well received by the participants as they reported liking the new method of tracking exercise intensity when using the pedometers. In addition, the CBEP participants felt the intervention motivated them to do more physical activity. The participants reported that the CBEP intervention meeting was motivational for them because it provided them with structure and specific goals to strive for. Specifically, it helped them determine their baseline physical activity levels. On the other hand, two participants reported having difficulty using CBEP for walking exercise because the CBEP was too hard to keep track of. With that in mind, the use of the Walk4Life MVPA pedometers [125] could be utilized with the CBEP intervention to help make CBEP easier for the participants to set cadence thresholds and to monitor time above and below the intensity threshold [125]. In addition, our data demonstrate that CBEP is at least as effective as SC for maintaining physical activity levels of previously inactive adults. Based on this data, we suggest that future research could improve upon the CBEP approach described in this thesis to optimize the intervention for physical activity promotion initiatives to provide patients who prefer to walk for exercise with the information and skills so they can walk at a moderate-to-vigorous intensity. In fact, more research needs to be conducted to optimize the effectiveness of CBEP so it is easier to use from the participant's perspective. Likewise, more research needs to be conducted to minimize the time it takes for a health care provider to instruct patients how to utilize the CBEP intervention.

Conclusions

To our knowledge, very few studies have utilized CBEP as a strategy to enhance the amount of $MVPA_{10min}$ being performed by adults. Our study showed that CBEP did not significantly enhance $MVPA_{10min}$ or $MVPA_{Spor}$, as compared to SC. Moreover, CBEP did not increase $Steps_{Total}$ and $Steps_{MVPA}$ over time compared to SC. However, the individuals that received the CBEP intervention felt it motivated them to do more physical activity. This study provides novel data for $Steps_{MVPA}$ that establishes baseline data for this parameter to guide future physical activity research. Our study demonstrated the feasibility of utilizing CBEP to increase the motivation of participants to perform more activity at MVPA. However, CBEP did not support participants to increase their total physical activity levels or time spent performing MVPA, as compared to SC.

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Appendices

A) CPAG for Adults – 18 – 64 Years

B) CPAG for Older Adults – 65 Years & Older

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P) Table 21: Comparison of MVPA steps per day with absolute changes in gender sub-groups

Appendix A: CPAG for Adults – 18 – 64 Years

Canadian Physical Activity Guidelines

FOR ADULTS - 18 – 64 YEARS

Guidelines

To achieve health benefits, adults aged 18-64 years should accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more.

It is also beneficial to add muscle and bone strengthening activities using major muscle groups, at least 2 days per week.

More physical activity provides greater health benefits.

Let's Talk Intensity!

Moderate-intensity physical activities will cause adults to sweat a little and to breathe harder. Activities like:

- Brisk walking
- Bike riding

Vigorous-intensity physical activities will cause adults to sweat and be 'out of breath'. Activities like:

- Jogging
- Cross-country skiing

Being active for at least **150 minutes** per week can help reduce the risk of:

- Premature death
- Heart disease
- Stroke
- High blood pressure
- Certain types of cancer
- Type 2 diabetes
- Osteoporosis
- Overweight and obesity

And can lead to improved:

- Fitness
- Strength
- Mental health (morale and self–esteem)

Pick a time. Pick a place. Make a plan and move more!

- ☑ Join a weekday community running or walking group.
- ☑ Go for a brisk walk around the block after dinner.
- ☑ Take a dance class after work.
- ☑ Bike or walk to work every day.
- ☑ Rake the lawn, and then offer to do the same for a neighbour.
- ☑ Train for and participate in a run or walk for charity!
- ☑ Take up a favourite sport again or try a new sport.
- ☑ Be active with the family on the weekend!

Now is the time. Walk, run, or wheel, and embrace life.

ParticipACTION

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Appendix B: CPAG for Older Adults – 65 Years & Older

Canadian Physical Activity Guidelines

FOR OLDER ADULTS - 65 YEARS & OLDER

Guidelines

To achieve health benefits, and improve functional abilities, adults aged 65 years and older should accumulate at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more.

It is also beneficial to add muscle and bone strengthening activities using major muscle groups, at least 2 days per week.

Those with poor mobility should perform physical activities to enhance balance and prevent falls.

More physical activity provides greater health benefits.

Let's Talk Intensity!

Moderate-intensity physical activities will cause older adults to sweat a little and to breathe harder. Activities like:

- Brisk walking
- Bicycling

Vigorous-intensity physical activities will cause older adults to sweat and be 'out of breath'. Activities like:

- Cross-country skiing
- Swimming

Being active for at least **150 minutes** per week can help reduce the risk of:

- Chronic disease (such as high blood pressure and heart disease) and,
- Premature death

And also help to:

- Maintain functional independence
- Maintain mobility
- Improve fitness
- Improve or maintain body weight
- Maintain bone health and,
- Maintain mental health and feel better

Pick a time. Pick a place. Make a plan and move more!

☑ Join a community urban poling or mall walking group.
☑ Go for a brisk walk around the block after lunch.
☑ Take a dance class in the afternoon.
☑ Train for and participate in a run or walk for charity!
☑ Take up a favourite sport again.
☑ Be active with the family! Plan to have "active reunions".
☑ Go for a nature hike on the weekend.
☑ Take the dog for a walk after dinner.

Now is the time. Walk, run, or wheel, and embrace life.

PARTICIPACTION

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Appendix C: Certified Exercise Physiologist (CEP) Scope of Practice and Competencies

CSEP CEP Scope of Practice

A CSEP CEP is sanctioned by CSEP to:

1. Administer appropriate assessment protocols for the evaluation of physical fitness to individuals who have been screened, signed an informed consent form and/or who have been cleared for unrestricted or restricted activity by a licensed health care professional.

2. Provide physical activity clearance following further queries to positive responses to questions 4, 5 and/or 7 on the PAR-Q. For example, an individual could be cleared for physical activity/exercise by a CSEP CEP if: (i) in question 4 it was determined that the dizziness was associated with over breathing during heavy exercise or sudden postural changes, (ii) in question 5 it was determined that the joint problem was an old knee, ankle, shoulder or other old joint constraint and (iii) in question 7 it was determined that the individual had a "cold" or relative contraindication such as, but not limited to, controlled diabetes or stable medicated blood pressure.

3. Provide physical activity clearance to clients who are screened out by PAR-Q questions 1 and/or 6. In these instances, until additional information is gathered, the CSEP CEP can recommend tailored, low intensity, progressive physical activity (such as walking).

4. Seek medical clearance for clients of any age who are screened out by PAR-Q questions 2 and/or 3 which deal with potential heart problems before providing physical activity recommendations.

5. Provide physical activity clearance and recommend tailored, progressive physical activity for clients over age 69 who do not respond positively to PAR-Q questions 2 and/or 3 which deal with potential heart problems.

6. Provide physical activity clearance to clients over age 69 and recommend tailored, progressive physical activity.

7. Provide physical activity clearance to youths under age 15 who have consent of their parent or guardian.

8. Interpret the results of an individual's fitness assessment to determine the individual's health-related fitness level and/or performance-related (function, work or sport) fitness level.

9. Use the outcomes from objective assessments to guide decisions regarding physical activity/exercise: prescription, demonstration, supervision and monitoring, fitness and healthy lifestyle counselling and act as a personal trainer.

10. Suggest healthy dietary practices in concert with physical activity/exercise programs for healthy weight management.

11. Suggest dietary practices for health-related nutrition and performance-related nutrition.

12. Use a heart rhythm tracing to observe heart response during a fitness assessment and a structured exercise session.

13. Evaluate and treat both asymptomatic and symptomatic populations with medical conditions, functional limitations and disabilities, through the application of exercise and physical activity, for the purpose of improving health and function.

14. Perform evaluations, prescribe conditioning exercise, and provide exercise supervision, health education and outcome evaluation.

15. Work with apparently healthy asymptomatic and symptomatic populations such as older adults, children and youth, and obstetric populations, and to society as a whole, in health enhancement and the prevention of impairment and disability.

16. Provide appropriate exercise therapy to clients including, but not limited to, those with musculoskeletal, cardio-respiratory, and metabolic conditions.

17. Accept referrals from licensed health care professionals trained to diagnose and treat musculoskeletal conditions and/or medical conditions.

A CSEP-CEP is not sanctioned by CSEP to:

1. Administer assessment protocols and prescribe exercise and/or therapy to acutely injured and diseased individuals who are not within the boundaries of the above scope of practice.

2. Diagnose pathology based on any assessment performed.

5 CSEP CEP CORE COMPETENCIES

Introduction

This section on the core competencies describes in detail, the depth and the breadth of knowledge, skills, and abilities a CSEP CEP Candidate must exhibit before the certification is granted. The CSEP CEP Candidate must demonstrate advanced capacities in all domains of the scope of practice.

> *Note: The depth and breadth of knowledge, skills and abilities outlined in the Core Competency section refers to that which would normally be acquired in the core and upper level elective courses of a university undergraduate degree program in physical activity/exercise sciences/kinesiology where ≥ 70 % of the university faculty members are specialists, who hold a PhD in a core competency domain.*

The Core Competencies are divided into **16 subject domains** each of which is further divided into sub-domains and specific competencies. This section should serve as an indication of the outcome expectancies demanded of the CSEP CEP and guide CSEP CEP Candidates in their preparation for the certification.

I. Anatomy and Biomechanics
II. Exercise Physiology
III. Human Development and Aging
IV. Physical Fitness Assessment Applications for: Health, Function and Work or Sport
V. Physical Activity and Exercise Prescription Applications for: Health, Function and Work or Sport
VI. Nutrition and Weight Management
VII. Data Management and Analysis
VIII. Health Promotion and Disease Prevention
IX. Psychosocial Aspects of Human Behaviour Applied to Physical Activity, Exercise, Rehabilitation and Exercise Therapy
X. Physical Activity/Exercise strategies and considerations for persons with chronic diseases, functional limitations and disabilities associated with: Cardiopulmonary/Metabolic Conditions, Musculoskeletal Conditions, Neuromuscular Conditions and Aging
XI. Pharmacology: commonly used agents for persons with chronic diseases, functional limitations and disabilities associated with: Cardiopulmonary/Metabolic Conditions, Musculoskeletal Conditions, Neuromuscular Conditions and Aging
XII. Evaluation: additional procedures for persons with chronic diseases, functional limitations and disabilities associated with: Cardiopulmonary/Metabolic Conditions, Musculoskeletal Conditions, Neuromuscular Conditions and Aging
XIII. Clinical Exercise Prescription
XIV. Client Education
XV. Professional Practice
XVI. Outcome Evaluation

A list of suggested resources/readings follows each Core Competency section. The list of suggested resources/readings are not intended to be exclusive, however they are a sample of the depth and the breadth of the knowledge, skills and abilities that a CSEP CEP is expected to possess.

The following Core Competency domains outline the applied fitness/exercise skills that will be examined during the OSPE examination:

IV. Physical Fitness Assessment Applications for: Health, Function and Work or Sport

V. Physical Activity and Exercise Prescription Applications for: Health, Function and Work or Sport

Note that any identified required resources/readings are essential for the performance expectations within the OSPE.

The following required resources will assist the CEP Candidate in the initial stages of their practical experience:

1. Heyward, V. H. (current edition) **Advanced Fitness Assessment and Exercise Prescription**. Champaign: Human Kinetics
2. CSEP (1998). **The Canadian Physical Activity, Fitness and Lifestyle Approach: CSEP's plan for healthy active living**. (current edition). Ottawa: Canadian Society for Exercise Physiology.
3. American College of Sports Medicine. **Exercise Management for Persons with Chronic Diseases and Disabilities**. Human Kinetics, 1997.
4. Health Canada and CSEP (1999 and 2002). **Canada's Physical Activity Guides to Healthy Active Living (for Children/Youth/Older Adults)**. Ottawa: Government of Canada.
5. **ACSM's Guidelines for Exercise Testing and Prescription**. (current edition). Baltimore: Lippincott Williams & Wilkins.
6. Delavier, F. **Strength Training Anatomy**. Current Edition. Champaign: Human Kinetics.

Appendix D: Risk Factor Identification Tool

Risk Factor Identification Tool – Assessment Content

The following list of questions provides an outline of the general content of the RFIT assessment. However, not all of these questions are asked and they do not follow the linear process in which they are presented. Rather, a unique algorithm produces a series of questions according to previous responses provided by each individual participant.

Screen 1 - This is a Risk Factor Identification Tool

This computer program will ask you questions about your health behaviours. A report will then be printed for you to keep for your information.

The care you receive from your doctor will not be affected if you choose not to use this program or decide to quit the program.

This is a touch screen. Press the "Next" button to find out more about RFIT

Screen 2-Consent

Your answers may be helpful to study different patient behaviours and how they affect health and wellness. Once you've answered the questions on this computer, the information is coded for privacy and may be sent to a protected research database. It may also be linked to other research databases for future studies. Your personal information such as your name or health number will not be part of the research database.

You can also continue with the survey without storing your information.

Will you allow your responses to be sent to the research database?

Yes

No

Screen 3: Instructions

We're ready to begin…

Your responses [will / will not] be stored in the research database.

Here is how you use the program:

- Each question can be answered by touching the screen.
- Once you have answered a question, press the "Next" button.
- By pressing the "Back" button you can go to the previous screen.
- To stop or exit the program at any time, press the "Quit" button.

To begin the program, please press the "Next" button now…

1. Personal Health Information Number
2. Name
3. Date of Birth
4. Sex
5. Height
6. Weight
7. Self rated health present and one year ago
8. In the past 12 months, how many times have you consulted or visited a physician outside of this clinic?
9. Do you regularly take any medications (prescription or over-the-counter) that have not been prescribed by a physician at this clinic?
10. Do you see a dental professional regularly (i.e. Yearly or more often)?

SMOKING

11. Check the answer that best describes you at the present time:
    - I have never smoked
    - I used to smoke but quit more than 10 years ago
    - I used to smoke but quit more than 1 year ago
    - I have quit smoking within the last year
    - I have cut back on the amount I smoke
    - I smoke regularly (i.e. daily, weekly, monthly or as a social smoker)
12. What strategy(s) did you use to quit smoking? (Select all that apply)
13. Assessment for readiness for change

DIET

14. How difficult would it be for you to stop smoking?
15. Do you currently have a healthy diet?
16. In a typical day, how many servings of fruit and vegetables would you eat?
17. In a typical day, how many servings of grain products would you eat?
18. In a typical day, how many servings of milk or alternates would you have?
19. Are you lactose intolerant?
20. In a typical day, how many servings of meat or alternates would you eat?
21. Are you a vegetarian?
22. How often do you choose whole grain bread, crackers and/or high fiber cereal?
23. In the past 7 days, how often did you eat breakfast (aprox. within 1 hour of rising)?
24. Which of the following best describes how you feel about your present weight?
25. Assessment of readiness for change
26. How confident are you that you could make some changes to your daily diet?

ALCOHOL USE/ABUSE

27. In a typical week, how many alcoholic drinks do you consume?
28. In a typical week, how many alcoholic drinks do you consume on one occasion?
29. Please select all the statements that describe you:
    - I've felt guilty or bad after drinking
    - I've needed a drink first thing in the morning to get going

It is time to cut down or stop drinking
I get annoyed when someone criticizes how much I drink
None of the above

30. Assessment of readiness for change

PHYSICAL ACTIVITY

31. From the following list of physical activities, select the activities you do during your typical or usual week. (Choose as many as you like)
    Basketball or Volleyball
    Squash or Racquetball
    Soccer, Football, Rugby or Lacrosse
    Hockey
    Skiing or Snowboarding
    Running
    Skating or Rollerblading
    Martial Arts
    Boxing or Wrestling
    Swimming
    None of these
32. Your selected activity _______________ (from previous question)
    a. What is the TOTAL number of times per week you do this activity?
    b. What is the TOTAL number of minutes per week you spend doing this activity?
33. Select the activities you do during your typical or usual week. (Choose as many as you like)
    Household chores
    Baseball or cricket
    Dance or Aerobics
    Bowling
    Weightlifting or Circuit Training
    Tennis or Badminton
    Gardening/Lawn Care or Shoveling Snow
    Cycling
    Walking (for exercise)
    Golf
    Curling
    Other activities
    None of these activities
34. The activities you selected (from previous question) are listed below on the left hand side of the screen. When you are doing these activities, how hard are you breathing?
    Heavy (I can barely talk)
    Moderate (I can maintain a conversation)
    Light (I can speak easily)
35. Heavy breathing activities selected (from previous question)
    c. What is the TOTAL number of times per week you do these activities?
    d. What is the TOTAL number of minutes per week you spend doing these activities?

36. Moderate breathing activities selected
    e. What is the TOTAL number of times per week you do these activities?
    f. What is the TOTAL number of minutes per week you spend doing these activities?
37. Assessment of readiness for change
38. How difficult would it be for you to increase your physical activity level?
39. Does your physical health or pain limit your work or activities?
40. Does your activity level change according to the seasons?
41. When riding a bicycle outdoors, how often do you wear a bicycle helmet?
42. Do you wear sunscreen with an SPF of 15 or greater when you are in the sunshine?
43. How often do you wear a hat to protect against sun exposure?
44. Are you presently employed?
45. Think about your workplace and any physical, chemical or other potential causes for injury. Are you able to identify any potential hazards?
46. How often do you protect yourself against potential hazards at your workplace?

The following questions are for patients over the age of 60.

47. Since last being seen by this doctor have you had a fall with an injury that caused you to limit your regular activities for at least one day or to go see a doctor?
48. Since last being seen by this doctor, have you been involved in more than 1 car crash or collision?
49. Which of the following statements are true for you?
    I have taken someone else's medication to help treat my ailment
    I sometimes miss a dose of my medication
    I sometimes take more or less of my medication depending on how I feel
    None of these statements apply to me

Questionnaire COMPLETE

Final Screen a-

Thank you for completing this questionnaire

Researchers are currently investigating ways of improving care for patients and addressing physical activity needs. You may be an eligible participant for a related study.

May we contact you with more information?

Yes

No

Final Screen b –

Using the keypad, please provide a phone number where research staff may call you to provide further information:

Appendix E: Pedometer Intervention Sheet

Pedometer Intervention Sheet

- The main objective of the intervention is to use a simple strategy to increase the time you spend walking at a moderate intensity when exercising.
- Preparation for the intervention meeting:
    - Bring the accelerometer to return to us.
    - Approach the intervention meeting the same way you would prepare to exercise.
    - Wear appropriate footwear that has laces.
    - The intervention meeting will take about an hour in total time.
    - You will be walking for approximately 30 minutes at moderate intensity during that time.
- You will be asked to wear a pedometer and a heart rate monitor that includes accessories, such as a watch and foot pod that attaches to your shoes.
- We will provide you with a steps/min prescription sheet to take with you to provide you with the number of steps you must take within a certain time to be considered walking at a moderate intensity.
- If you have any questions feel free to contact Eric Garcia by phone at .

Pedometer Intervention Meeting

Date (MM/DD/YY)	_____/_____/_____	
Time:	_____ : _____	AM: ___ PM: ___
Location:		

Appendix F: Patient's Information Sheets

Intervention Number: __________ Subject Number: ________

PATIENT'S INFORMATION SHEET

Date (MM/DD/YY)	_____/_____/_____	
Time:	_____ : _____	AM: ___ PM: ___
Location:		
Name of evaluator(s):		
Signature(s):		

Patient's Characteristics

Name: ______________________________	Int #: ________ Sub #: ________
Address: _______________________________	Gender: Female ( ) Male ( )
Age: ____ years Height: ___ft.___inches / _____cm	Weight: ____lbs/____kg
Phone #: Home: (___)____-_____ Cell: (___)____-_____ Work: (___)____-_____ AED Location : ______________________________	

Do you think you are reaching moderate intensity when you currently exercise? Y / N

Max HR = 207 – (0.7 X AGE) Max HR = 207 – (0.7 X ________)

Max HR: _______ (beats/min) HR Rest: _______ (beats/min)

HR Reserve = Max HR – HR Rest HR Reserve = __________ – _________

HR Reserve: _______ (beats/min)

Minimal Moderate Intensity Target HR (50% HRR) = (HRR X 0.50) + HR Rest

50% HRR = (______ X 0.50) + ________ 50% HRR: _____ (beats/min)

Minimal Moderate Intensity Target Cadence: ______ (steps/min)

Borg Scale Rating: ______

6 Minute Walking Test (Wear Pedometer)

HR: _______ (beats/min) Cadence: ________ (steps/min) Borg Scale Rating: ______

Walk distance: ______(metres) VO2 Max: ____________ (mL/kg/min)

Aged 20-59: VO2 Max (mL/kg/min) = 70.161 + (0.023 X 6MWT [m]) – (0.276 X weight [kg]) – (6.79 X sex, where m = 0 or f = 1) – (0.193 X resting HR [beats per minute]) – (0.191 X age [years])

Aged 20-59: VO2 Max (mL/kg/min) = 70.161 + (0.023 X _________) – (0.276 X ______) – (6.79 X ___) – (0.193 X ______) – (0.191 X ______)

Pedometer Intervention (Trial bouts 2 – 3 minutes in length)

Trial #	HR (beats/Min)	Cadence(steps/MIN)	0-10 RPE
1			
2			
3			
4			
5			

Additional Comments: ____

____

____

____

____

Appendix G: Individualized Cadence-Based Pedometer Exercise Prescription Sheet

Steps Per Minute Prescription

Desired Walking session duration (minutes)	# of steps to reach moderate intensity
5	
10	
15	
20	
25	
30	
35	
40	
45	
50	
55	
60	

Minimal Moderate Intensity Target Cadence: ______ (steps/min)

- **Steps per minute prescriptions only apply when pedometer is worn during walking sessions.**
- **If you have any questions, feel free to contact Eric Garcia by phone at or by email at .**
- **We will do a phone follow-up in about 2 weeks and 6 weeks.**

Appendix H: Pedometer Intervention Follow-up Script

Pedometer Intervention Follow-up Script

Hi, can I speak to ___________*(Participant's name)* please? My name is __________ from Access _______________ *(Whichever site they were recruited from).*
I am a researcher working on the ENCOURAGE project with Alex and we did a pedometer intervention meeting with you about a month ago at _____________ *(State location)* about walking at a moderate intensity using a target steps per minutes. I am just calling to follow-up with you. I just had a few questions for you. Is now a good time? It will take about 5 minutes.

Q1: Have you been using the pedometer since your meeting with Eric and I?

(Yes , No, Sometimes)

IF NO: Why don't you use the pedometer anymore?
A) Forgetting to wear it
B) Don't find it useful
C) Too much work/added stress
D) D) Lost it/broke it/gave it back to Alex - we can give another one
E) E) Other

Q2: When are you wearing the pedometer?

A) N-A
B) When you exercise
C) For the whole day (including physical activity period)

Q3: Do you like this new method of tracking exercise intensity?

A) Yes
B) No
C) Not sure
D) Yes in theory, but have not used it yet
E) Helped to identify moderate but not using perscription

Q4: What are the main challenges to using the pedometer for exercise alone?? (why you are not only using the pedometer when exercising as proposed in our meeting ?)

A) Forgetting to put on at all or reset
B) Forgetting to calculate steps at moderate intensity
C) Don't find it useful
D) Too hard to calculate/keep track of
E) I'd rather count total steps per day
F) None
G) Not enough time
H) Other
I) Did not understand

Q 5: Is the steps per minute prescription motivating you to do MORE physical activity?

(Yes , No / Activity levels the same as before)

Q 6: How much WALKING physical activity have you been doing in one normal week?

____

Q 7: Which goal do you prefer?

A) Trying to reach 10000 steps per day
B) Trying to reach the prescribed steps per minute to reach moderate intensity
C) Both

Q 8: Did the intervention in general motivate you to do MORE physical activity?
(Yes, No, not sure, helped to maintain activity levels)

Q 9: Overall, did you find the intervention meeting helpful?
(Yes, No, not sure, somewhat)

IF YES: How so?
A) Informative
B) Motivational
C) Provides structure and goals
D) Helps determine baseline
E) Fun
F) Liked the researchers
G) Other

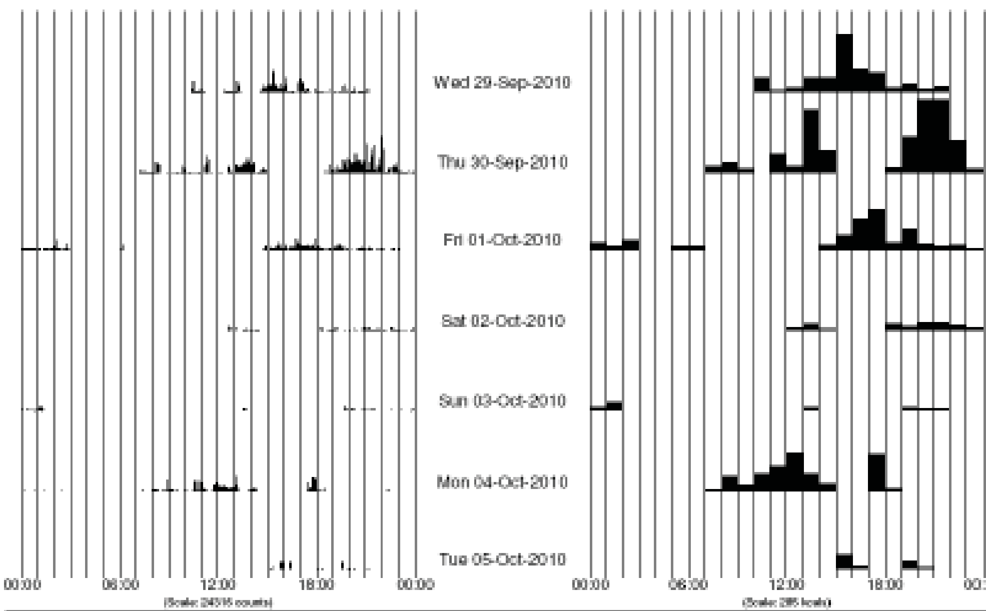
IF NO: Why not?
A) Confusing
B) Too hard to reach/discouraging
C) Too much work
D) Didn't like the researchers
E) Not enjoyable
F) Took too long
G) Hard to make routine
H) Other
I) Did not understand

Thank you so much for taking the time to answer our questions. We really appreciate your participation in the project. ....Do you have any technical issues about the pedometer you want to discuss? .....Do you have any questions for me? We value your feedback very much.....

Appendix I: Accelerometer Output Examples

Actical Activity and Energy Expenditure Report (AEE)

Subject Identity	Ihor			**Gender**	Male
Subject Height	193.0 cm (76.0 in)	**Weight**	90.7 kg (200.0 lbs)	**Age**	22 years
Data Collection Start Time	Wed, 29-Sep-2010, 10:21	**Data Collection End Time**	Wed, 06-Oct-2010, 08:00	**Device Serial Number**	B111400
Energy Expenditure Output Type	Activity Energy Expenditure (AEE)	**Regression Model**	Single (1R)	**Age Level**	Adult
Light/Moderate Cut-point	0.031 kcals/min/kg	**Moderate/Vigorous Cut-point**	0.083 kcals/min/kg	**Device Location**	Hip



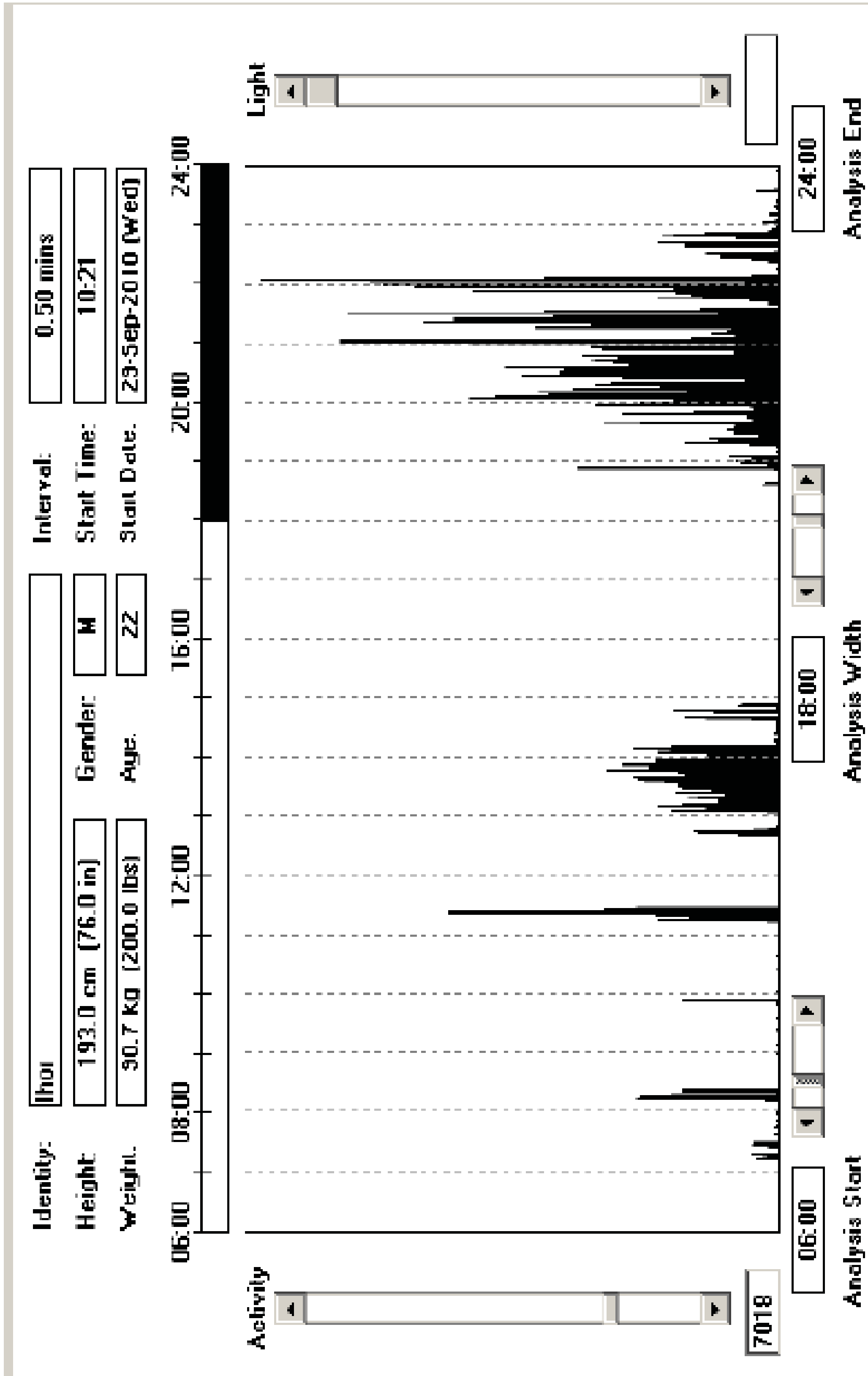
Day	Daily Energy Expenditure Total (kcals)*	SED	LIGHT	MOD	VIG
		Minutes in Physical Activity Range			
Wed 29-Sep-2010	666	592	88	134	3
Thu 30-Sep-2010	1376	1071	102	247	20
Fri 01-Oct-2010	601	1160	150	130	0
Sat 02-Oct-2010	157	1351	60	29	0
Sun 03-Oct-2010	84	1390	33	17	0
Mon 04-Oct-2010	663	1226	79	134	1
Tue 05-Oct-2010	111	1399	18	23	0
Total Activity Energy Expenditure for 7 Days Shown Above (kcals)*	**3658**	8189	530	714	24

* Does NOT include resting metabolic rate in statistics and graphs

A person of this age, gender, weight, and height needs 2130 calories to maintain their normal bodily functions.

(Based on Harris J, Benedict F. A biometric study of basal metabolism in man. Washington D.C. Carnegie Institute of Washington. 1919)

Printed: Wed, 06-Oct-2010 08:04 Mini Mitter Company, Inc. Page 1 of 1


Identity:
Ihor
Height:
193.0 cm (76.0 in)
Weight:
90.7 kg (200.0 lbs)
Gender:
M
Age:
22
Interval:
0.50 mins
Start Time:
10:21
Start Date:
29-Sep-2010 (Wed)
06:00
08:00
12:00
16:00
20:00
24:00
Activity
Light
7018
06:00
Analysis Start
18:00
Analysis Width
24:00
Analysis End

Appendix J: Table 15: Comparison of physical activity in 10 minute bouts with absolute changes between SC and CBEP

Table 15. Comparison of physical activity measured in 10 minute bouts between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
10 Minute Bouts				
$TotalPA_{10min}$ (mins/week)				
SC	**48 ± 16**	**90 ± 41**	**71 ± 30**	**41 ± 10**
CBEP	**37 ± 10**	**44 ± 15**	**48 ± 11**	**47 ± 14**
T2-T1				
SC	-	-	***7 (-27 to 41)***	-
CBEP	-	-	***0 (-54 to 54)***	-
T3-T1				
SC	-	-	-	***0 (-25 to 25)***
CBEP	-	-	-	***-19 (-57 to 19)***
T3-T2				
SC	-	-	-	***0 (-27 to 27)***
CBEP	-	-	-	***0 (-38 to 38)***
$MVPA_{10min}$ (mins/week)				
SC	**21 ± 12**	**30 ± 26**	**36 ± 28**	**16 ± 9**
CBEP	**22 ± 8**	**25 ± 15**	**30 ± 11**	**28 ± 12**
T2-T1				
SC	-	-	***6 ± 7***	-
CBEP	-	-	***5 ± 6***	-
T3-T1				
SC	-	-	-	***-15 ± 22***
CBEP	-	-	-	***2 ± 18***
T3-T2				
SC	-	-	-	***-21 ± 23***
CBEP	-	-	-	***-3 ± 14***
$MET\text{-}min_{Total10min}$ (MET-min/week)				
SC	**176 ± 64**	**295 ± 158**	**293 ± 192**	**109 ± 27**
CBEP	**140 ± 40**	**181 ± 66**	**148 ± 30**	**146 ± 43**

T2-T1				
SC	***-***	***-***	***7 (-50 to 64)***	***-***
CBEP	***-***	***-***	***-18 (-509 to 473)***	***-***
T3-T1				
SC	***-***	***-***	***-***	***0 (-82 to 82)***
CBEP	***-***	***-***	***-***	***-54 (-184 to 76)***
T3-T2				
SC	***-***	***-***	***-***	***0 (-47 to 47)***
CBEP	***-***	***-***	***-***	***0 (-123 to 123)***
$MVPA_{AE\text{-}CPAG}$				
SC	**0 (0%)**	**1 (7%)**	**1 (7%)**	**0 (0%)**
CBEP	**0 (0%)**	**1 (6%)**	**1 (6%)**	**1 (6%)**
$TotalPA_{Bouts10min}$ (bouts/day)				
SC	**0.5 ± 0.2**	**0.5 ± 0.2**	**0.5 ± 0.1**	**0.4 ± 0.1**
CBEP	**0.4 ± 0.1**	**0.4 ± 0.1**	**0.4 ± 0.1**	**0.4 ± 0.1**
$MVPA_{Bouts10min}$ (bouts/day)				
SC	**0.2 ± 0.1**	**0.1 ± 0.1**	**0.1 ± 0.1**	**0.1 ± 0.1**
CBEP	**0.2 ± 0.1**	**0.2 ± 0.1**	**0.2 ± 0.1**	**0.2 ± 0.1**

Values are means ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (Percentage of group). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity; *MET*, metabolic equivalent; $MVPA_{AE\text{-}CPAG}$, met the aerobic exercise recommendations in the Canadian Physical Activity Guidelines based on $MVPA_{10min}$; $TotalPA_{Bouts10min}$, number of bouts of total physical activity performed for 10 minutes or longer per day; $MVPA_{Bouts10min}$, number of bouts of moderate to vigorous physical activity performed for 10 minutes or longer per day.

Appendix K: Table 16: Comparison of physical activity in sporadic bouts with absolute changes between SC and CBEP

Table 16. Comparison of sporadic physical activity between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
Sporadic Bouts				
$TotalPA_{Spor}$ (mins/week)				
SC	**1186 ± 150**	**1342 ± 118**	**1128 ± 144**	**1200 ± 158**
CBEP	**1226 ± 94**	**1230 ± 105**	**1189 ± 104**	**1204 ± 105**
T2-T1				
SC	-	-	***-213 ± 97***	-
CBEP	-	-	***-42 ± 79***	-
T3-T1				
SC	-	-	-	***-141 ± 104***
CBEP	-	-	-	***-27 ± 96***
T3-T2				
SC	-	-	-	***0 (-124 to 124)***
CBEP	-	-	-	***0 (-134 to 134)***
T2-T1/T1				
SC	-	-	***-15 ± 7%***	-
CBEP	-	-	***-0.2 ± 6%***	-
T3-T1/T1				
SC	-	-	-	***-4 (-16 to 24%)***
CBEP	-	-	-	***-8 (-30 to 14%)***
T3-T2/T2				
SC	-	-	-	***0 (-11 to 11%)***
CBEP	-	-	-	***0 (-13 to 13%)***
$MVPA_{Spor}$ (mins/week)				
SC	**124 ± 21**	**122 ± 26**	**95 ± 31**	**99 ± 20**
CBEP	**139 ± 19**	**150 ± 25**	**134 ± 18**	**129 ± 19**
T2-T1				
SC	-	-	***-26 ± 20***	-
CBEP	-	-	***-15 ± 20***	-

T3-T1				
SC	-	-	-	***-23 ± 19***
CBEP	-	-	-	***-20 ± 20***
T3-T2				
SC	-	-	-	***4 (-10 to 18)***
CBEP	-	-	-	***-2 (-29 to 25)***
T2-T1/T1				
SC	-	-	***-41 (-85 to 3%)***	-
CBEP	-	-	***-11 (-57 to 35%)***	-
T3-T1/T1				
SC	-	-	-	***-19 (-49 to 11%)***
CBEP	-	-	-	***-17 (-55 to 21%)***
T3-T2/T2				
SC	-	-	-	***4 (-35 to 43%)***
CBEP	-	-	-	***- 5 (-26 to 16%)***
MET-min$_{TotalSpor}$ (MET-min/week)				
SC	**3528 ± 488**	**3530 ± 362**	**2894 ± 492**	**3025 ± 461**
CBEP	**3998 ± 287**	**4260 ± 413**	**3159 ± 284**	**3213 ± 347**
T2-T1				
SC	-	-	***-933 (-1420 to -446)***	-
CBEP	-	-	***-1261 (-2639 to 117)***	-
T3-T1				
SC	-	-	-	***-1047 (-1940 to -154)***
CBEP	-	-	-	***-1482 (-2391 to -573)***
T3-T2				
SC	-	-	-	***0 (-648 to 648)***
CBEP	-	-	-	***0 (-850 to 850)***
T2-T1/T1				
SC	-	-	***-32 (-49 to -15%)***	-
CBEP	-	-	***-27 (-55 to 1%)***	-
T3-T1/T1				
SC	-	-	-	***-24 (-50 to 2%)***
CBEP	-	-	-	***-34 (-48 to -20%)***

T3-T2/T2				
SC	**-**	**-**	**-**	***0 (-38 to 38%)***
CBEP	**-**	**-**	**-**	***0 (-30 to 30%)***

Values are means ± standard error or median (25th to 75th percentile). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity; *MET*, metabolic equivalent. Time effect for MET-$min_{TotalSpor}$ where T0, T1 > T2, T3 ($p<0.05$).

Appendix L: Table 17: Comparison of total steps per day between SC and CBEP

Table 17. Comparison of total steps taken per day measured in sporadic bouts between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
Steps				
$Steps_{Total}$ (steps/day)				
SC	**5751 ± 711**	**6417 ± 627**	**5515 ± 943**	**5712 ± 740**
CBEP	**6439 ± 572**	**6379 ± 709**	**5370 ± 500**	**6102 ± 702**
Absolute Change				
T2-T1				
SC	**-**	**-**	***-903 ± 506***	**-**
CBEP	**-**	**-**	***-1009 ± 613***	**-**
T3-T1				
SC	**-**	**-**	**-**	***-705 ± 635***
CBEP	**-**	**-**	**-**	***-277 ± 629***
T3-T2				
SC	**-**	**-**	**-**	***0 (-1545 to 1545)***
CBEP	**-**	**-**	**-**	***0 (-1156 to 1156)***
Relative Change				
T2-T1/T1				
SC	**-**	**-**	***-28 (-56 to 0%)***	**-**
CBEP	**-**	**-**	***-13 (-37 to 11%)***	**-**
T3-T1/T1				
SC	**-**	**-**	**-**	***3 (-32 to 38%)***
CBEP	**-**	**-**	**-**	***-10 (-52 to 32%)***
T3-T2/T2				
SC	**-**	**-**	**-**	***0 (-48 to 48%)***
CBEP	**-**	**-**	**-**	***0 (-30 to 30%)***
$Steps_{10,000}$				
SC	**1 (7%)**	**2 (13%)**	**4 (27%)**	**3 (20%)**
CBEP	**1 (6%)**	**3 (18%)**	**1 (6%)**	**2 (12%)**

Values are means ± standard error or median (25^{th}-75^{th} percentile). Categorical variables expressed in frequencies (percentage of group). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 2 month time point; *T2*, 4 month time point; *T3*, 6 month time point; *T2-T1*, Change from 2 to 4 month time point; *T3-T1*, Change from 2 to 6 month time point; *T3-T2*, Change from 4 to 6 month time point; *T2-T1/T1*, Percent change from 2 to 4 month time point; *T3-T1/T1*, Percent change from 2 to 6 month time point; *T3-T2/T2*, Percent change from 4 to 6 month time point; $Steps_{10,000}$, reached 10,000 total steps per day.

Appendix M: Table 18: Comparison of MVPA steps per day between SC and CBEP

Table 18. Comparison of moderate-to-vigorous steps taken per day measured in sporadic bouts between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
Steps				
Steps$_{MVPA}$ (steps/day)				
SC	**1742 ± 315**	**1710 ± 434**	**1390 ± 523**	**1329 ± 261**
CBEP	**2019 ± 283**	**2154 ± 407**	**1904 ± 270**	**1825 ± 265**
Absolute Change				
T2-T1				
SC	-	-	***-320 ± 248***	-
CBEP	-	-	***-249 ± 306***	-
T3-T1				
SC	-	-	-	***-136 (-835 to 563)***
CBEP	-	-	-	***-556 (-1348 to 236)***
T3-T2				
SC	-	-	-	***30 (-222 to 282)***
CBEP	-	-	-	***0 (-538 to 538)***
Relative Change				
T2-T1/T1				
SC	-	-	***-41 (-75 to -7%)***	-
CBEP	-	-	***-2 (-42 to 38%)***	-
T3-T1/T1				
SC	-	-	-	***-14 (-50 to 22%)***
CBEP	-	-	-	***-20 (-62 to 22%)***
T3-T2/T2				
SC	-	-	-	***4 (-51 to 59%)***
CBEP	-	-	-	***0 (-28 to 28%)***

Values are means ± standard error or median (25th-75th percentile). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 2 month time point; *T2*, 4 month time point; *T3*, 6 month time point; *T2-T1*, Change from 2 to 4 month time point; *T3-T1*, Change from 2 to 6 month time point; *T3-T2*, Change from 4 to 6 month time point; *T2-T1/T1*, Percent change from 2 to 4 month time point; *T3-T1/T1*, Percent change from 2 to 6 month time point; *T3-T2/T2*, Percent change from 4 to 6 month time point; *MVPA*, moderate to vigorous physical activity.

Appendix N: Table 19: Comparison of RFIT self-reported physical activity between SC and CBEP

Table 19. Comparison of self-reported physical activity between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) using the Risk Factor Identification Tool (RFIT) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	**T1**	**T2**	**T3**
$RFIT_{MVPA}$ (mins/week)				
SC	**322 ± 200**	**576 ± 234**	**466 ± 167**	**312 ± 163**
CBEP	**668 ± 266**	**543 ± 225**	**589 ± 248**	**639 ± 277**
T2-T1				
SC	**-**	**-**	***-111 ± 252***	**-**
CBEP	**-**	**-**	***46 ± 81***	**-**
T3-T1				
SC	**-**	**-**	**-**	***-265 ± 150***
CBEP	**-**	**-**	**-**	***95 ± 140***
T3-T2				
SC	**-**	**-**	**-**	***-163 (-311 to -15)***
CBEP	**-**	**-**	**-**	***0 (-311 to 311)***
$RFIT_{AE\text{-}CPAG}$				
SC	**4 (40%)**	**8 (80%)**	**7 (70%)**	**5 (50%)**
CBEP	**6 (46%)**	**7 (54%)**	**7 (54%)**	**10 (77%)**

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (percentage of group). *SC*, Standard Care group n=10; *CBEP*, Cadenced-Based Exercise Prescription group n=13. *MVPA*, moderate to vigorous physical activity; $RFIT_{AE\text{-}CPAG}$, met the aerobic exercise recommendations in the Canadian Physical Activity Guidelines based on $MVPA_{10min}$; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point.

Appendix O: Table 20: Comparison of SF-12 health survey results between SC and CBEP

Table 20. Comparison of self-reported quality of life between the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) using the Short-form 12 quality of life questionnaire (SF-12) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
SF-12 Survey Data				
Physical functioning				
SC	**38 ± 3%**	**44 ± 3%**	**43 ± 3%**	**40 ± 3%**
CBEP	**42 ± 2%**	**44 ± 2%**	**43 ± 3%**	**45 ± 3%**
T2-T1				
SC	-	-	***-1 ± 2%***	-
CBEP	-	-	***-1 ± 2%***	-
T3-T1				
SC	-	-	-	***-2 (-6 to 2%)***
CBEP	-	-	-	***1 (-4 to 6%)***
T3-T2				
SC	-	-	-	***-3 ± 2%***
CBEP	-	-	-	***2 ± 2%***
T2-T1/T1				
SC	-	-	***-0.4 ± 4%***	-
CBEP	-	-	***-2 ± 5%***	-
T3-T1/T1				
SC	-	-	-	***-7 ± 4%***
CBEP	-	-	-	***2 ± 4%***
T3-T2/T2				
SC	-	-	-	***-10 (-24 to 4%)***
CBEP	-	-	-	***5 (-7 to 17%)***
Mental functioning				
SC	**46 ± 3%**	**45 ± 3%**	**48 ± 3%**	**50 ± 3%**
CBEP	**47 ± 3%**	**49 ± 2%**	**52 ± 3%**	**50 ± 3%**
T2-T1				
SC	-	-	***3 ± 3%***	-
CBEP	-	-	***3 ± 2%***	-

T3-T1				
SC	**-**	**-**	**-**	***4 ± 4%***
CBEP	**-**	**-**	**-**	***1 ± 3%***
T3-T2				
SC	**-**	**-**	**-**	***2 ± 3%***
CBEP	**-**	**-**	**-**	***-2 ± 3%***
T2-T1/T1				
SC	**-**	**-**	***2 (-12 to 16%)***	**-**
CBEP	**-**	**-**	***6 (-10 to 22%)***	**-**
T3-T1/T1				
SC	**-**	**-**	**-**	***8 (-12 to 28%)***
CBEP	**-**	**-**	**-**	***3 (-20 to 26%)***
T3-T2/T2				
SC	**-**	**-**	**-**	***4 (-8 to 16%)***
CBEP	**-**	**-**	**-**	***3 (-5 to 11%)***

Values are mean ± standard error or median (25th to 75th percentile). *SC*, Standard Care group n=16; *CBEP*, Cadenced-Based Exercise Prescription n=19. *SF-12*, Short-form 12 Questionnaire; *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point. Time effect for physical functioning where T0 < T1, T3 ($p<0.05$).

Appendix P: Table 21: Comparison of MVPA steps per day with absolute changes in gender sub-groups

Table 21. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down by their gender to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	**T1**	**T2**	**T3**
Gender (female)				
Female	**2199 ± 255**	**2383 ± 370**	**1997 ± 371**	**1759 ± 233**
Male	**1209 ± 264**	**983 ± 327**	**929 ± 299**	**1227 ± 303**
Absolute Change				
T2-T1				
Female	-	-	***-386 ± 256***	-
Male	-	-	***-54 ± 290***	-
T3-T1				
Female	-	-	-	***-624 ± 282***
Male	-	-	-	***244 ± 339***
T3-T2				
Female	-	-	-	***0 (-619 to 619)***
Male	-	-	-	***12 (-220 to 244)***
Relative Change				
T2-T1/T1				
Female	-	-	***-11 (-45 to 23%)***	-
Male	-	-	***-24 (-117 to 69%)***	-
T3-T1/T1				
Female	-	-	-	***-20 (-55 to 15%)***
Male	-	-	-	***-0.4 (-94 to 94%)***
T3-T2/T2				
Female	-	-	-	***0 (-37 to 37%)***
Male	-	-	-	***2 (-25 to 29%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down by gender. Female n=22; Male n=10. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity. Group effect for gender where $Gender_{female} > Gender_{male}$ ($p<0.05$).

Appendix Q: Table 22: Comparison of MVPA steps per day with absolute changes in age sub-groups

Table 22. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on their age being below or above the median age of 52 years to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Age (52 years)				
Age_{young}	**2185 ± 244**	**2287 ± 424**	**1888 ± 245**	**1888 ± 250**
Age_{old}	**1593 ± 330**	**1604 ± 405**	**1439 ± 515**	**1298 ± 270**
Absolute Change				
T2-T1				
Age_{young}	**-**	**-**	***-399 ± 322***	**-**
Age_{old}	**-**	**-**	***-165 ± 234***	**-**
T3-T1				
Age_{young}	**-**	**-**	**-**	***-317 (-1300 to 666)***
Age_{old}	**-**	**-**	**-**	***-170 (-692 to 352)***
T3-T2				
Age_{young}	**-**	**-**	**-**	***0 (-484 to 484)***
Age_{old}	**-**	**-**	**-**	***12 (-388 to 412)***
Relative Change				
T2-T1/T1				
Age_{young}	**-**	**-**	***-5 (-38 to 28%)***	**-**
Age_{old}	**-**	**-**	***-20 (-60 to 20%)***	**-**
T3-T1/T1				
Age_{young}	**-**	**-**	**-**	***-13 (-50 to 24%)***
Age_{old}	**-**	**-**	**-**	***-19 (-57 to 19%)***
T3-T2/T2				
Age_{young}	**-**	**-**	**-**	***0 (-23 to 23%)***
Age_{old}	**-**	**-**	**-**	***3 (-53 to 59%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on their age being below, equal to, or above the median age of 52 years. Age_{young} n=16; Age_{old} n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity.

Appendix R: Table 23: Comparison of MVPA steps per day with absolute changes in weight sub-groups

Table 23. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them based on their weight being under or over the median weight of 103 kg to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Weight (103 kg)				
$Weight_{under}$	**2080 ± 355**	**1793 ± 433**	**1825 ± 514**	**1675 ± 221**
$Weight_{over}$	**1699 ± 221**	**2098 ± 411**	**1502 ± 252**	**1511 ± 312**
Absolute Change				
T2-T1				
$Weight_{under}$	-	-	***-64 (-981 to 853)***	-
$Weight_{over}$	-	-	***-126 (-777 to 525)***	-
T3-T1				
$Weight_{under}$	-	-	-	***-83 (-960 to 794)***
$Weight_{over}$	-	-	-	***-397 (-1184 to 390)***
T3-T2				
$Weight_{under}$	-	-	-	***134 (-540 to 808)***
$Weight_{over}$	-	-	-	***0 (-113 to 113)***
Relative Change				
T2-T1/T1				
$Weight_{under}$	-	-	***2 (-63 to 67%)***	-
$Weight_{over}$	-	-	***-15 (-38 to 8%)***	-
T3-T1/T1				
$Weight_{under}$	-	-	-	***-9 (-72 to 54%)***
$Weight_{over}$	-	-	-	***-35 (-72 to 2%)***
T3-T2/T2				
$Weight_{under}$	-	-	-	***11 (-82 to 104%)***
$Weight_{over}$	-	-	-	***0 (-11 to 11%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on their weight being under, equal to, or over the median weight of 103 kg. $Weight_{under}$ n=16; $Weight_{over}$ n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity.

Appendix S: Table 24: Comparison of MVPA steps per day with absolute changes in BMI sub-groups

Table 24. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on their BMI being under or over the median BMI of 36 kg/m^2 to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
BMI (36 kg/m^2)				
BMI_{under}	**1954 ± 323**	**1544 ± 280**	**1422 ± 324**	**1530 ± 232**
BMI_{over}	**1825 ± 273**	**2347 ± 510**	**1904 ± 468**	**1655 ± 305**
Absolute Change				
T2-T1				
BMI_{under}	-	-	***-122 ± 248***	-
BMI_{over}	-	-	***-442 ± 309***	-
T3-T1				
BMI_{under}	-	-	-	***-14 ± 263***
BMI_{over}	-	-	-	***-691 ± 365***
T3-T2				
BMI_{under}	-	-	-	***46 (-557 to 649)***
BMI_{over}	-	-	-	***0 (-254 to 254)***
Relative Change				
T2-T1/T1				
BMI_{under}	-	-	***-12 (-56 to 32%)***	-
BMI_{over}	-	-	***-11 (-34 to 12%)***	-
T3-T1/T1				
BMI_{under}	-	-	-	***-9 (-58 to 40%)***
BMI_{over}	-	-	-	***-35 (-66 to -4%)***
T3-T2/T2				
BMI_{under}	-	-	-	***6 (-87 to 99%)***
BMI_{over}	-	-	-	***0 (-16 to 16%)***

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on their BMI being under, equal to, or over the median BMI of 36 kg/m^2. BMI_{under} n=16; BMI_{over} n=16. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity; *BMI*, body mass index.

Appendix T: Table 25: Comparison of MVPA steps per day in seasonal sub-groups

Table 25. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on the season they began participating in the ENCOURAGE study to compare moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	**T1**	**T2**	**T3**
The season they participated in the ENCOURAGE study.				
Spring/Summer	**1940 ± 232**	**1911 ± 336**	**1642 ± 236**	**1755 ± 225**
Fall/Winter	**1761 ± 467**	**2033 ± 635**	**1718 ± 843**	**1178 ± 325**
Absolute Change				
T2-T1				
Spring/Summer	-	-	***-270 ± 247***	-
Fall/Winter	-	-	***-314 ± 328***	-
T3-T1				
Spring/Summer	-	-	-	***-145 (-932 to 642)***
Fall/Winter	-	-	-	***-631 (-1320 to 58)***
T3-T2				
Spring/Summer	-	-	-	***0 (-407 to 407)***
Fall/Winter	-	-	-	***24 (-425 to 473)***
Relative Change				
T2-T1/T1				
Spring/Summer	-	-	***-13 (-53 to 27%)***	-
Fall/Winter	-	-	***-9 (-54 to 36%)***	-
T3-T1/T1				
Spring/Summer	-	-	-	***-19 (-60 to 22%)***
Fall/Winter	-	-	-	***-27 (-60 to 6%)***
T3-T2/T2				
Spring/Summer	-	-	-	***0 (-25 to 25%)***
Fall/Winter	-	-	-	***4 (-38 to 46%)***

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and separated them into two season groups (spring/summer group and fall/winter group) depending on the month they started the ENCOURAGE study. Spring/Summer (March to August) n=23; Fall/Winter (September to February) n=9. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; *MVPA*, moderate to vigorous physical activity.

Appendix U: Table 26: Comparison of total steps per day in gender sub-groups

Table 26. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them by their gender to compare total steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Gender (female)				
Female	**5942 ± 473**	**6613 ± 515**	**5447 ± 585**	**5626 ± 600**
Male	**6500 ± 1018**	**5921 ± 1021**	**5417 ± 1035**	**6565 ± 932**
Absolute Change				
T2-T1				
Female	-	-	***-1166 ± 452***	-
Male	-	-	***-504 ± 805***	-
T3-T1				
Female	-	-	-	***-988 ± 535***
Male	-	-	-	***644 ± 690***
T3-T2				
Female	-	-	-	***178 ± 546***
Male	-	-	-	***1148 ± 546***
Relative Change				
T2-T1/T1				
Female	-	-	***-17 ± 6%***	-
Male	-	-	***-0.1 ± 18%***	-
T3-T1/T1				
Female	-	-	-	***-12 ± 8%***
Male	-	-	-	***28 ± 20%***
T3-T2/T2				
Female	-	-	-	***0 (-37 to 37%)***
Male	-	-	-	***18 (-19 to 55%)***
$Steps_{10,000}$				
$Gender_{female}$	**0 (0%)**	**3 (14%)**	**3 (14%)**	**2 (9%)**
$Gender_{male}$	**2 (20%)**	**2 (20%)**	**2 (20%)**	**3 (30%)**

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). Categorical variables expressed in frequencies (Percentage of group). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them by gender. Female n=22; Male n=10. *T0*, baseline time point; *T1*, 8 weeks time point; *T2*, 16 weeks time point; *T3*, 24 weeks time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 weeks time point; *T3-T1/T1*, Percent change from 8 to 24 weeks time point; *T3-T2/T2*, Percent change from 16 to 24 weeks time point; $Steps_{10,000}$, reached 10,000 total steps per day.

Appendix V: Table 27: Comparison of total steps per day in age sub-groups

Table 27. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their age being below, equal to, or above the median age of 52 years to compare total steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Age (52 years)				
Age_{young}	**7187 ± 637**	**7195 ± 683**	**6440 ± 724**	**6552 ± 777**
Age_{old}	**5046 ± 519**	**5599 ± 603**	**4436 ± 635**	**5286 ± 621**
Absolute Change				
T2-T1				
Age_{young}	-	-	***-756 ± 635***	-
Age_{old}	-	-	***-1163 ± 491***	-
T3-T1				
Age_{young}	-	-	-	***-643 ± 649***
Age_{old}	-	-	-	***-313 ± 618***
T3-T2				
Age_{young}	-	-	-	***113 ± 468***
Age_{old}	-	-	-	***850 ± 689***
Relative Change				
T2-T1/T1				
Age_{young}	-	-	***-10 (-38 to 18%)***	-
Age_{old}	-	-	***-30 (-54 to -6%)***	-
T3-T1/T1				
Age_{young}	-	-	-	***-15 (-50 to 20%)***
Age_{old}	-	-	-	***2 (-32 to 36%)***
T3-T2/T2				
Age_{young}	-	-	-	***7 ± 10%***
Age_{old}	-	-	-	***44 ± 20%***
$Steps_{10,000}$				
Age_{young}	**2 (13%)**	**4 (25%)**	**4 (25%)**	**4 (25%)**
Age_{old}	**0 (0%)**	**1 (6%)**	**1 (6%)**	**1 (6%)**

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (Percentage of group). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their age being below, equal to, or above the median age of 52 years. Age_{young} n=16; Age_{old} n=16. *T0*, baseline time point; *T1*, 8 weeks time point; *T2*, 16 weeks time point; *T3*, 24 weeks time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 weeks time point; *T3-T1/T1*, Percent change from 8 to 24 weeks time point; *T3-T2/T2*, Percent change from 16 to 24 weeks time point; *$Steps_{10,000}$*, reached 10,000 total steps per day. Group effect for age where $Age_{young} > Age_{old}$ ($p<0.05$).

Appendix W: Table 28: Comparison of total steps per day in weight sub-groups

Table 28. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their weight being under, equal to, or over the median weight of 103 kg to compare total steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Weight (103 kg)				
$Weight_{under}$	**6089 ± 667**	**5634 ± 508**	**5456 ± 777**	**5760 ± 540**
$Weight_{over}$	**6144 ± 619**	**7160 ± 761**	**5420 ± 677**	**6079 ± 865**
Absolute Change				
T2-T1				
$Weight_{under}$	-	-	***-178 ± 566***	-
$Weight_{over}$	-	-	***-1741 ± 498****	-
T3-T1				
$Weight_{under}$	-	-	-	***126 ± 632***
$Weight_{over}$	-	-	-	***-1082 ± 598***
T3-T2				
$Weight_{under}$	-	-	-	***607 (-768 to 1982)***
$Weight_{over}$	-	-	-	***0 (-1263 to 1263)***
Relative Change				
T2-T1/T1				
$Weight_{under}$	-	-	***-2 ± 12%***	-
$Weight_{over}$	-	-	***-22 ± 5%***	-
T3-T1/T1				
$Weight_{under}$	-	-	-	***13 (-19 to 45%)***
$Weight_{over}$	-	-	-	***-16 (-43 to 11%)***
T3-T2/T2				
$Weight_{under}$	-	-	-	***9 (-34 to 52%)***
$Weight_{over}$	-	-	-	***0 (-34 to 34%)***
$Steps_{10,000}$				
$Weight_{under}$	**1 (6%)**	**0 (0%)**	**3 (19%)**	**2 (13%)**
$Weight_{over}$	**1 (6%)**	**5 (31%)***	**2 (13%)**	**3 (19%)**

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). Categorical variables expressed in frequencies (Percentage of group). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their weight being under, equal to, or over the median weight of 103 kg. $Weight_{under}$ n=16; $Weight_{over}$ n=16. *T0*, baseline time point; *T1*, 8 weeks time point; *T2*, 16 weeks time point; *T3*, 24 weeks time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 weeks time point; *T3-T1/T1*, Percent change from 8 to 24 weeks time point; *T3-T2/T2*, Percent change from 16 to 24 weeks time point; $Steps_{10,000}$, reached 10,000 total steps per day; *, different than the $Weight_{under}$ group ($p<0.05$) .

Appendix X: Table 29: Comparison of total steps per day in BMI sub-groups

Table 29. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their BMI being under, equal to, or over the median BMI of 36 kg/m^2 to compare total steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
BMI (36 kg/m^2)				
BMI_{under}	**6103 ± 684**	**5962 ± 592**	**5133 ± 714**	**5775 ± 646**
BMI_{over}	**6131 ± 600**	**6833 ± 734**	**5743 ± 734**	**6064 ± 789**
Absolute Change				
T2-T1				
BMI_{under}	-	-	***-829 ± 596***	-
BMI_{over}	-	-	***-1090 ± 541***	-
T3-T1				
BMI_{under}	-	-	-	***-187 ± 651***
BMI_{over}	-	-	-	***-769 ± 610***
T3-T2				
BMI_{under}	-	-	-	***432 (-1126 to 1990)***
BMI_{over}	-	-	-	***0 (-1263 to 1263)***
Relative Change				
T2-T1/T1				
BMI_{under}	-	-	***-22 (-57 to13%)***	-
BMI_{over}	-	-	***-14 (-33 to 5%)***	-
T3-T1/T1				
BMI_{under}	-	-	-	***5 (-24 to 34%)***
BMI_{over}	-	-	-	***-16 (-50 to 18%)***
T3-T2/T2				
BMI_{under}	-	-	-	***40 ± 21%***
BMI_{over}	-	-	-	***10 ± 9%***
$Steps_{10,000}$				
BMI_{under}	**1 (6%)**	**1 (6%)**	**2 (13%)**	**2 (13%)**
BMI_{over}	**1 (6%)**	**4 (25%)**	**3 (19%)**	**3 (19%)**
BMI_{Steps} (kg/m^2 * steps per day)				
SC	**209624 ± 28299**	**232065 ± 25391**	**202926 ± 36904**	**205445 ± 28347**
CBEP	**236843 ± 18807**	**239196 ± 27097**	**196155 ± 15514**	**225416 ± 26160**

BMI_{Steps} (kg/m^2 * steps per day)				
BMI_{under}	**198228 ± 22561**	**194400 ± 20483**	**165998 ± 23436**	**187057 ± 21611**
BMI_{over}	**249940 ± 22979**	**277306 ± 27374**	**232660 ± 27723**	**245053 ± 30212**

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). Categorical variables expressed in frequencies (Percentage of group). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and divided them based on their BMI being under, equal to, or over the median BMI of 36 kg/m^2. BMI_{under} n=16; BMI_{over} n=16. *T0*, baseline time point; *T1*, 8 weeks time point; *T2*, 16 weeks time point; *T3*, 24 weeks time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 weeks time point; *T3-T1/T1*, Percent change from 8 to 24 weeks time point; *T3-T2/T2*, Percent change from 16 to 24 weeks time point; *BMI*, body mass index; $Steps_{10,000}$, reached 10,000 total steps per day; BMI_{Steps}, work of moving calculated by multiplying BMI * $Steps_{Total}$. Group effect for BMI_{Steps} where, $BMI_{under} < BMI_{over}$ ($p<0.05$).

Appendix Y: Table 30: Comparison of total steps per day in seasonal sub-groups

Table 30. We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and broke them down based on the season they began participating in the ENCOURAGE study to compare total steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
The season they participated in the ENCOURAGE study.				
Spring/Summer	**6354 ± 542**	**6444 ± 584**	**5261 ± 581**	**5991 ± 586**
Fall/Winter	**5511 ± 795**	**6276 ± 805**	**5890 ± 1065**	**5737 ± 1030**
Absolute Change				
T2-T1				
Spring/Summer	-	-	***-1184 ± 459***	-
Fall/Winter	-	-	***-386 ± 791***	-
T3-T1				
Spring/Summer	-	-	-	***-454 ± 559***
Fall/Winter	-	-	-	***-539 ± 701***
T3-T2				
Spring/Summer	-	-	-	***730 ± 410***
Fall/Winter	-	-	-	***-153 ± 1060***
Relative Change				
T2-T1/T1				
Spring/Summer	-	-	***-17 (-40 to 6%)***	-
Fall/Winter	-	-	***-1 (-36 to 34%)***	-
T3-T1/T1				
Spring/Summer	-	-	-	***-5 (-37 to 27%)***
Fall/Winter	-	-	-	***-19 (-48 to 10%)***
T3-T2/T2				
Spring/Summer	-	-	-	***0 (-34 to 34%)***
Fall/Winter	-	-	-	***0 (-43 to 43%)***
$Steps_{10,000}$				
Spring/Summer	**2 (9%)**	**4 (17%)**	**3 (13%)**	**3 (13%)**
Fall/Winter	**0 (0%)**	**1 (11%)**	**2 (22%)**	**2 (22%)**

Continuous variables expressed as mean ± standard error or median (25th to 75th percentile). We pooled the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) accelerometer data and separated them into two season groups (spring/summer group and fall/winter group) depending on the month they started the ENCOURAGE study. Spring/Summer (March to August) n=23; Fall/Winter (September to February) n=9. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *T2-T1*, Change from 8 to 16 week time point; *T3-T1*, Change from 8 to 24 week time point; *T3-T2*, Change from 16 to 24 week time point; *T2-T1/T1*, Percent change from 8 to 16 week time point; *T3-T1/T1*, Percent change from 8 to 24 week time point; *T3-T2/T2*, Percent change from 16 to 24 week time point; $Steps_{10,000}$, reached 10,000 total steps per day.

Appendix Z: Table 31: Comparison of total and MVPA steps per day between SC and CBEP separated into seasonal sub-groups

Table 31. We separated the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) based on the season they began participating in the ENCOURAGE study to compare total and moderate-to-vigorous (MVPA) steps per day at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
$Steps_{Total}$ (steps/day)				
Spring/Summer				
SC	**5829 ± 1011**	**6739 ± 927**	**5053 ± 1249**	**5726 ± 1067**
CBEP	**6691 ± 625**	**6255 ± 775**	**5394 ± 563**	**6161 ± 705**
Fall/Winter				
SC	**5635 ± 1040**	**5935 ± 780**	**6207 ± 1522**	**5691 ± 1047**
CBEP	**5262 ± 1461**	**6959 ± 2093**	**5255 ± 1311**	**5827 ± 2690**
$Steps_{MVPA}$ (steps/day)				
Spring/Summer				
SC	**1575 ± 318**	**1417 ± 362**	**1006 ± 338**	**1317 ± 341**
CBEP	**2174 ± 315**	**2229 ± 492**	**2050 ± 278**	**2037 ± 281**
Fall/Winter				
SC	**1992 ± 655**	**2148 ± 971**	**1966 ± 1238**	**1349 ± 447**
CBEP	**1299 ± 555**	**1802 ± 305**	**1224 ± 828**	**836 ± 428**

Continuous variables expressed as mean ± standard error or median (25^{th} to 75^{th} percentile). We separated the Standard Care group (SC) and Cadenced-based Exercise Prescription group into two season groups (spring/summer group and fall/winter group) depending on the month they started the ENCOURAGE study. SC in Spring/Summer (March to August) n=9; CBEP in Spring/Summer (March to August) n=14; SC in Fall/Winter (September to February) n=6; CBEP in Fall/Winter (September to February) n=3. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *MVPA*, moderate to vigorous physical activity.

Appendix AA: Table 32: Comparison of valid accelerometer days and length of wear times between SC and CBEP

Table 32. Comparison of the number of valid accelerometer days and hours valid daily wear times for the Standard Care group (SC) and Cadenced-Based Exercise Prescription group (CBEP) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3).

	T0	T1	T2	T3
Valid Accelerometer Days (#)				
SC	**6 ± 0.3**	**5 ± 0.4**	**5 ± 0.4**	**5 ± 0.5**
CBEP	**7 ± 0.3**	**7 ± 0.4**	**6 ± 0.3**	**5 ± 0.3**
Wear Time (hours/day)				
SC	**12.4 ± 0.4**	**12.5 ± 0.4**	**12.5 ± 0.4**	**12.5 ± 0.4**
CBEP	**13.1 ± 0.3**	**12.5 ± 0.4**	**12.1 ± 0.4**	**12.1 ± 0.3**

Values are means ± standard error or median (25^{th} to 75^{th} percentile). *SC*, Standard Care group n=15; *CBEP*, Cadenced-Based Exercise Prescription group n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point. Group effect for Valid Accelerometer Days, where SC < CBEP ($p<0.05$). Time effect for Valid Accelerometer Days, where T0, T1 > T2, T3 ($p<0.05$).

Appendix BB: Table 15: CBEP accelerometer data sub-analysis comparing standard and individualized cut-points

Table 33. Comparison of physical activity measured in 10 minute and sporadic bouts between accelerometer data from the Cadenced-Based Exercise Prescription group analyzed using standard cut-points ($CBEP_{Standard}$) and Cadenced-Based Exercise Prescription group analyzed using individualized cut-points ($CBEP_{Individual}$) at baseline (T0), 8 weeks (T1), 16 weeks (T2), and 24 weeks (T3) as measured using an accelerometer.

	T0	T1	T2	T3
10 Minute Bouts				
$TotalPA_{10min}$ (mins/week)				
$CBEP_{Standard}$	37 ± 10	44 ± 15	48 ± 11	47 ± 14
$CBEP_{Individual}$	35 ± 10	42 ± 14	48 ± 12	44 ± 13
$MVPA_{10min}$ (mins/week)				
$CBEP_{Standard}$	22 ± 8	25 ± 15	30 ± 11	28 ± 12
$CBEP_{Individual}$	21 ± 8	24 ± 14	30 ± 11	27 ± 11
Sporadic Bouts				
$TotalPA_{Spor}$ (mins/week)				
$CBEP_{Standard}$	1226 ± 94	1230 ± 105	1189 ± 104	1204 ± 105
$CBEP_{Individual}$	1226 ± 94	1230 ± 105	1189 ± 104	1204 ± 105
$MVPA_{Spor}$ (mins/week)				
$CBEP_{Standard}$	139 ± 19	150 ± 25	134 ± 18	129 ± 19
$CBEP_{Individual}$	137 ± 18	145 ± 23	131 ± 17	129 ± 18
$Steps_{Total}$ (steps/day)				
$CBEP_{Standard}$	6439 ± 572	6379 ± 709	5370 ± 500	6102 ± 702
$CBEP_{Individual}$	6439 ± 572	6379 ± 709	5370 ± 500	6102 ± 702
$Steps_{MVPA}$ (steps/day)				
$CBEP_{Standard}$	2019 ± 283	2154 ± 407	1904 ± 270	1825 ± 265
$CBEP_{Individual}$	1996 ± 272	2097 ± 389	1872 ± 256	1820 ± 255

Values are means ± standard error or median (25^{th} to 75^{th} percentile). *$CBEP_{Standard}$*, Cadenced-Based Exercise Prescription group accelerometer data analyzed using standard cut-points n=17; *$CBEP_{Individual}$*, Cadenced-Based Exercise Prescription group accelerometer data analyzed using individualized cut-points n=17. *T0*, baseline time point; *T1*, 8 week time point; *T2*, 16 week time point; *T3*, 24 week time point; *MVPA*, moderate to vigorous physical activity. Time effect for $Steps_{Total}$ where T0, T1 > T2 ($p<0.05$).