A Feasibility Study Evaluating an Online Physical Activity Intervention for Young Adults with Low Mood and/or Depression Engaged in Community Primary Clinical Care

by

Aleah Ross
Bachelor of Science, from University of Victoria, 2015

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Supervisory Committee

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Abstract

Background: Exercise is now recommended as a frontline treatment for depression (DS) in Canada. Implementation is an ongoing challenge.

Purpose: The aim of this study was to evaluate the feasibility of a novel, online, physical activity (PA) intervention for youth with DS.

Methods: ***Study 1:*** Semi-structured interviews were conducted with end-users to evaluate an existing alpha-intervention and inform intervention changes. ***Study 2:*** This study was a randomized, feasibility pilot trial of a 10-week, online, PA beta-intervention designed using the Multi-Process Action Control (M-PAC) framework with a waitlist control. Youth aged 19-30 with mild to moderate DS not meeting Canada PA guidelines were recruited via community clinics and social media. Primary feasibility outcomes were recruitment rate, retention rate, and acceptability. Planned analyses included a qualitative thematic analysis, frequency counts and multiple one-way, between-groups ANCOVAs.

Results: ***Study 1***: Thematic analysis of seven participants' interview data determined good initial acceptability, demand, and practicality. Five change ideas were integrated within a beta-intervention for trial. ***Study 2:*** Low rates of recruitment (N= 26, 21.7% total; 3.8% clinical), retention (n= 16, 61.5%), and acceptability (n= 11, 64.0%) were found. Secondary outcomes of PA ($\eta_p^2 = 0.55$) and DS ($\eta_p^2 = 0.18$), as well as tertiary M-PAC behavioural variables: behavioural regulation ($\eta_p^2 = 0.46$) and identity ($\eta_p^2 = 0.20$), all favored the intervention group.

Conclusions: Despite initial evidence of acceptability and demand, this trial is not recommended for RCT; rather further pilot research is required including active control group(s) and multi-site approaches to bolster recruitment.

Table of Contents

List of Tables

List of Figures

Operational Definitions

1) Mental Health

"Mental health is the state of your psychological and emotional well-being. It is a necessary resource for living a healthy life and a main factor in overall health. It does not mean the same thing as mental illness. However, poor mental health can lead to mental and physical illness" ("About mental health - Canada.ca," n.d.).

2) Mental Illness

"Mental illnesses are described as disturbances in thoughts, feelings, and perceptions that are severe enough to affect day-to-day functioning. Some examples are anxiety disorders, schizophrenia, and mood disorders, such as major depressive disorder and bipolar disorder" ("Mental health: What is it, really? - CMHA National," n.d.).

3) Physical Activity

"Physical activity refers to all movement including during leisure time, for transport to get to and from places, or as part of a person's work." (WHO, 2020).

4) Leisure-Time Physical Activity

"Leisure time physical activities are those physical activities that are not required as essential activities of daily living and are performed at the discretion of the person. These include activities such as sports, exercising, and recreational walking." (Moore et al., 2012, p. 2).

5) Exercise

Exercise is a planned and structured form of physical activity aimed at increasing the conditioning of the human body.

6) Primary and Community Clinical Care

Care provided primarily by a General Practioner (i.e., family doctor) in the community outside of the hospital inpatient or outpatient setting.

7) Mental Health Professional

A healthcare professional able to be certified under a national body licensed to provide training, education, and treatment recommendations to aid mental health.

8) Major Depressive Disorder (MDD)

"A period of at least two weeks during which there is either depressed mood or the loss of interest or pleasure in nearly all activities. …The mood in a major depressive episode is often described by the person as depressed, sad, hopeless, discouraged or 'down in the dumps'" (DSM-V, APA, 2013, p. 163). Major Depressive Disorder is diagnosed when five or more symptoms based on the Diagnostic and Statistical Manual – Fifth Edition Diagnostic Criteria are met.

9) Mild Depression

"Few, if any, symptoms in excess of those required to make the diagnosis are present, the intensity of the symptoms is distressing but manageable, and the symptoms result in minor impairment in social or occupational functioning." (DSM-V, APA, 2013, p. 188)

10) Moderate Depression

"The number of symptoms is substantially in excess of that required to make the diagnosis, the intensity of the symptoms is seriously distressing and unmanageable, and the symptoms markedly interfere with social and occupational functioning." (DSM-V, APA, 2013, p. 188)

11) Severe Depression

"The number of symptoms is substantially in excess of that required to make the diagnosis, the intensity of the symptoms is seriously distressing and unmanageable, and the symptoms markedly interfere with social and occupational functioning." (DMS-V, APA, 2013, p. 188).

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Dedication

I would like to dedicate this thesis to all those who offered me love, support, and guidance to get through these years of challenging training during a global pandemic. I think this undertaking in itself would have been enough for us all without the added global turmoil, so I sincerely thank you for your courage to push (me) onwards!

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Chapter 1 Literature Review

1.1 Prevalence of MDD

Mood disorders are the most prevalent of mental disorders among the general population for both men and women. One review estimates "the pooled period prevalence of mood disorders across 148 surveys was 5.4% (4.9–6.0%) with a pooled lifetime prevalence of 9.6% (8.5–10.7%) across 83 surveys" (Lai et al., 2015). Other reviews have reported the global prevalence of MDD alone is 4.7% (Steel et al., 2014). Across studies, women appear to have a 3-7% higher prevalence for mood disorders than men (Lai et al., 2015; Steel et al., 2014). All of these statistics do not take into consideration the high level of underreporting associated with self-report data, particularly for men (O'Donnell et al., 2016). Furthermore, prevalence rates are higher among special populations, including young adult college students and racialized groups (Martin et al., 2013). For example, Hop Wo and colleagues (Hop Wo et al., 2020) found that self-identifying Indigenous post-secondary students in Canada were more likely to be diagnosed with MDD over 12 months, as well as over the life course, compared with non-Indigenous students. All of these statistics are concerning for the public health of the entire globe.

Compounding on concerns around high prevalence is data indicating that prevalence rates of mental illness are on the rise. For example, one recent repeated cross-sectional study conducted over a period of 20 years indicated an increased prevalence of common mental disorders (Fu et al., 2013). Such studies have been controversial, especially considering the alarm they incite. While Fu and colleagues (2013) indicated that prevalence rates in their study showed a two-fold increase, more recent systematic reviews and meta-analyses have suggested that the increase might be a bit more

conservative. Baxter and colleagues (2014) conducted "a systematic review of prevalence, remission, duration, and excess mortality studies for anxiety disorders and MDD" (p. 506), and found no significant change in the prevalence of either disorder between 1990 and 2010. However, a post-hoc search did reveal some trends in global prevalence towards increased psychological distress. Richter and colleagues (2019) conducted a systematic review and meta-analysis of literature between 1992 and 2017 and determined "an overall global prevalence increase in odds ratio of 1.179" (p. 393) for common mental illnesses. Heterogeneity of the samples across both of these systematic reviews and meta-analyses is certainly a limitation. Altogether, both of these research teams highlighted the importance of recognizing the increase in population and the shift in age demographics towards older adults who tend to have a higher prevalence of mental health concerns (Baxter et al., 2014; Richter et al., 2019). Regardless of how these potential increases might be explained, they still represent additional weight on the global health system. One study by Patten and colleagues (Patten, 2016) reported an increased number of hospitalizations for MDD and increased prescription for some psychopharmacological treatments in Canada. Their analysis of survey data also sadly lent support for the suggestion that despite these treatment efforts MDD prevalence and psychological distress are, at minimum, not decreasing. The prevalence of mental illness and MDD continues to be a relevant concern, and this is especially given the risks associated with decreased mental health.

1.2 Health Risks of MDD

1.2.1 Higher Risk of Chronic Disease Comorbidities

MDD is independently associated with a higher risk of developing a countless number of comorbid chronic illnesses through a variety of lifestyle pathways. Some

observational evidence indicates that lower daytime activity, lower fitness and less restful sleep could all be contributors to the development of physiological pathways of disease (Faurholt-Jepsen et al., 2012). Weight gain is often associated with a diagnosis of MDD, and can potentially be three to four times higher among patients opting for first-time anti-psychotic drug treatment (Alvarez-Jiménez et al., 2008)-- a common psychiatric approach for individuals diagnosed with MDD. A qualitative study by McCloughen and colleagues (McCloughen et al., 2016) supports these findings. Young people, ages 16-24, commented on how "weight change, poor sleep, and limited exercise adversely impacted their lives and self-image… and limited health literacy compromised effective management of physical health" (p. 1). Mykletun and colleagues (Mykletun et al., 2007) conducted a seminal population-based study, and one of the first ever examining possible mechanisms behind a wide range of MDD comorbidities. Interestingly, their findings lent much support to the contribution of lifestyle factors over potential biological mechanisms. Researchers have since gone on to discover some promising findings around epigenetic methylation of serotonin transporter gene *SLC6A4* and genotype expressions which could also be contributing to MDD (Kenna et al., 2012; Palma-Gudiel & Fañanás, 2017; Zhao et al., 2013). That said, much research still needs to be done to understand the total range of mechanisms behind MDD-associated risks. Currently, lifestyle factors are repeatedly implicated in the development of comorbid chronic disease for MDD patients.

Much attention to the association between CVD and MDD has been longstanding, but many MDD comorbidities are emerging. There is strong and proliferating evidence that MDD is associated with an increase for cardiovascular disease (Van der Kooy et al.,

2007). Studies examining this association alone were the focus of MDD comorbidity research for many years, but recently this field has expanded. For example, Pan and colleagues (Pan et al., 2011) found that diagnosis with MDD is associated with an increased risk of stroke morbidity and mortality. Research has also shown a high rate of comorbidity between MDD and Substance-Use Disorders (SUDs) (Lai et al., 2015). More generally, Bobo and colleagues (Bobo et al., 2016) have emphasized the indiscriminatory nature of MDD and it's growing list of well-established comorbid chronic diseases. They highlight how various somatic conditions have been established as comorbid diseases with MDD, but also share their research study which provides evidence for MDD also "being highly comorbid with asthma, arrhythmias, and lipid disorders in cohort members as young as 20-39 years" (p. 1487). They go on to assert that these findings are shared by over 39 previous studies investigating multimorbidity in populations with depression (Bobo et al., 2016). Mykletun and colleagues (2007) lend support to such findings. They affirm that "depression is a risk factor for all major disease-related causes of death" (p. 323). Countless recent studies continue to support the many chronic disease risks for people with MDD.

1.2.2 Adverse Outcomes Associated with MDD

MDD is associated with a variety of adverse outcomes and these include disability adjusted life years, victimization of many forms, and premature death. Gore and colleagues (Gore et al., 2011) provide evidence that neuropsychiatric disorders are the number one cause of years lost due to disability. Unipolar major depression was the leading disorder impacting life years for adults age 10-24 years, and also dominated the scales of global proportion of burden for young people at 20% (Gore et al., 2011).

Unfortunately, adverse associations are also present in the form of victimization. Individuals diagnosed with MDD are approximately 4-6 times more likely to be victimized in comparison to the general community without MDD (de Vries et al., 2019). This includes sexual, violent, and non-violent acts. Significant risk factors for victimization include alcohol abuse, unemployment, and homelessness, which are prevalent in psychiatric populations (de Vries et al., 2019). Also very concerning is the increased risk of premature natural and unnatural mortality associated with mental illness (Wahlbeck et al., 2011). Wahlbeck and colleagues posit a two- to three-fold increase in premature mortality for individuals with mental illness. This is due to a multitude of reasons, including increased suicidality, accidental and violent deaths, and poorer access to appropriate healthcare (Gore et al., 2011; Thornicroft, 2011; Wahlbeck et al., 2011). Together, these articles strongly indicate disparities within public health that have serious adverse consequences for young people with mental illness and/or MDD.

1.3 Treatment Approaches for MDD

1.3.1 Traditional, Non-Activity-Based Treatment Approaches for MDD

Physical activity (PA) is an incredible treatment avenue worth further exploration for individuals with MDD when the challenges, side-effects, and adverse outcomes associated with more traditional treatments are considered. The Government of British Columbia provides specific guidelines for clinicians around appropriate conventional treatment approaches (Government of B.C., 2013). The scope of their recommendations is for non-pregnant individuals age 19-65. Interestingly, this scope is already a limitation in itself for a considerable number of patients, such as pregnant women. These guidelines also recognize additional risk factors associated with these common conventional treatment approaches for individuals over 65, and therefore these guidelines do not

pertain to those individuals who may require special care. The number of individuals in need of care that are not able to be included in the province's conventional treatment recommendations due to potential risks already makes a significant contribution to the argument for alternative approaches.

Psychotherapy is recommended for the acute phase of mild to moderate depression, but has limitations. CBT and Interpersonal Therapy (IPT) are both recommended first-line forms of psychotherapy treatments (Government of B.C., 2013). It is known that psychotherapy can be as effective as drug treatment (Cuijpers, Andersson, Donker, & van Straten, 2011), but it can also be incredibly inaccessible. Given that such therapy requires one-on-one or small-group care and considerable time on the part of the patient and clinician, this can be incredibly challenging for an overburdened and underfunded mental healthcare system. Particularly in the Greater Victoria area, psychiatrists and other mental health professionals certified to provide psychotherapy are in incredibly high demand, and the referral and waitlist process can be long. Vancouver Island Health Authorities' Mental Health and Substance-Use outpatient services declared a state of crisis in fall 2020 given overwhelming case loads for current psychiatric specialists, the need for funding to hire more providers, and growing waitlists of patients unable to be seen. While psychotherapy is a great treatment option with minimal associated risk, it is not accessible to everyone in Canada.

Pharmacological treatment can require a laborious journey on the part of patient and physician in order to find an acceptable treatment protocol for individuals with MDD. Initially, patients are often prescribed a range of first-line antidepressants. There is often a considerable lag until the patient might see the first signs of potential mood

improvements (Kupfer et al., 2012). There are also a great number of these medications, each with their own potential side effects (Kennedy et al., 2016). Patients must be closely clinically monitored for some weeks after prescription, and there is significant potential for individuals to require multiple attempts to find a drug with tolerable effects for the individual. It is important to highlight that finding a good pharmacotherapeutic fit does not often mean finding a drug without *any* side effects, instead it most commonly means finding one with tolerable side effects.

Potential pharmacologic side effects are many and can be quite a serious risk to the health and wellbeing of the individual. Unfortunately, the very approaches used to support individuals in need of clinical care can often result in iatrogenic effects (Thornicroft, 2011). Side effects include the addition or increase of suicidal ideation, suicide risk, sexual dysfunction, psycho-motor agitation and more (Government of B.C., 2013). Additionally, taking antidepressant medications as well as commonly prescribed antipsychotic medications can result in weight gain (Kennedy et al., 2016). This is concerning given how a pattern of decreased movement is already associated with a diagnosis of MDD, and increasing BMI only adds to this burden as well as the associated risk for the development of comorbid chronic illness (Kearns et al., 2014; Nejat, Polotsky, & Pal, 2010). Relatedly, Tang and colleagues (2020) found that the use of antidepressants leads to more drug use for comorbid chronic diseases. Furthermore, therapeutic drugs are associated with increased cardio-metabolic risk when combined with a sedentary lifestyle (Vancampfort et al., 2015). Another concern with pharmacotherapy is the potential for drug-drug interactions (Kennedy et al., 2016). As such, pharmacotherapy is recommended only for moderate to severe major depression

given the increased risks associated with such treatment (Government of B.C., 2013). While pharmacotherapy can be an important treatment avenue for many, it does include some inherent risks to patients already experiencing significant disease burden.

1.3.2 Complementary and Alternative Medicine (CAM) Interventions for MDD

Over 120 CAM interventions have been identified, however, only physical and meditative interventions, and natural health products have sufficient evidence to be recommended as CAM for individuals with MDD currently (Ravindran et al., 2016). For mild to moderate MDD specifically, first- or second-line treatments include "exercise, light therapy, St. John's wort, omega-3 fatty acids, SAM-e, and yoga" (p. 576). Encouragingly, all of these treatments are generally significantly better-tolerated by patients in comparison to first-line antidepressant drugs. While limited, some side-effects are still possible, and depend on the CAM of choice. For example, omega-3 fatty acids have potential to cause diarrhea or nausea. In general, the limited side-effects and adverse outcomes associated with each of these treatments is a considerable advantage, making them ideal for recommendation as monotherapies and adjunctive treatments.

Exercise is one of only three first-line CAM interventions recommended by CANMAT for MDD patients considering strong supportive evidence as to its considerable effectiveness and many benefits (Ravindran et al., 2016). Importantly, exercise is also recommended as a powerful second-line, adjunct CAM. CANMAT reports that adverse outcomes associated with PA rarely occur within exercise or PA for depression intervention trials. The authors note that a dose of just 30 MVPA minutes 3 times weekly (any modality) is considered generally effective. Importantly, efficacy and effectiveness evidence is strong for exercise (Danielsson et al., 2013; Josefsson et al.,

2014; Krogh et al., 2011; Silveira et al., 2013; Stanton & Reaburn, 2014). Much of this evidence has been discussed in previous sections, and points firmly to the effectiveness of exercise for depression. The formal recommendation of exercise as an important treatment approach for individuals with MDD by organizations such as CANMAT is important to ongoing promotion efforts.

1.3.3 Limitations of PA as a Treatment for MDD

While PA has strong and growing evidence of its benefits for a variety of clinical mental health populations, it has its limitations. In some cases, PA alone may not be a functional approach to treatment, such as for those with severe depressive symptoms. Exercise has not been recommended as a first-line nor a monotherapy for these individuals considering that "many of the desirable outcomes of exercise for people with [severe mental illness], such as mood improvement, stress reduction and increased energy, are inversely related to the barriers of depression, stress and fatigue which frequently restrict their participation in exercise" (Firth et al., 2016). CANMAT instead recommends that individuals with severe depression consider exercise as a second-line adjunctive therapy (Ravindran et al., 2016). While it is known that there are virtually no contraindications to PA for individuals with depression (Ravindran et al., 2016; Rhodes et al., 2011), some individuals will require more direct forms of pharmacological treatment and/or psychotherapy. Of note however, is that PA can be a powerful addition to any treatment program for depression to support greater outcomes over and above treatment as usual (TAU; Danielsson et al., 2013). Like any treatment approach, PA must be prescribed appropriately, but it can offer considerable benefits for individuals with all degrees of depression.

When considering PA prescription as treatment for MDD, adoption and maintenance can be challenging and will likely require unique and tailored approaches to manage barriers. Individuals with mental illness diagnoses are known to experience a considerable range of additional correlates to reduced PA in comparison to the general population without mental health illness, or with subthreshold symptoms (Glowacki et al., 2017; Vancampfort, et al., 2015). These barriers exist on top of the already existing barriers that the general population without any indication of mental illness will face. Such barriers discussed previously in more detail include accessibility, finances, motivation, and so much more. Identification and management of these barriers are key to the success of PA as an alternative or adjunctive treatment approach.

There is also simply a lot we don't know about PA and its relationship with factors pertaining to MDD patients, and as such, pharmacotherapy is still the leading recommendation for most MDD patients over CAM (Ravindran et al., 2016). Less rigorous efficacy and effectiveness trials, fewer studies on CAM interventions, as well as considerable lack of evidence concerning interaction effects for both CAM with traditional pharmacotherapy and CAM with other CAM are just some of the evidentiary limitations. CANMAT has aligned their treatment recommendations accordingly. A considerable amount of ongoing research is required to expand on the benefits, contraindications, side-effects, interaction effects, and efficacy and effectiveness of CAM treatments, so that they might be more trusted and frequently recommended for future MDD patients.

1.4 PA and MDD

1.4.1 Benefits of PA for Young Adults with MDD

PA is generally associated with a decreased prevalence of depression for all ages (Chan et al., 2019; Kim et al., 2012). This relationship has been shown to be curvilinear, where anywhere from 2.5 to 7.5 hours of weekly PA result in hyperbolic gains for mental health (Kim et al., 2012). Recommendations around the intensity, duration, and modality of PA bouts for the greatest gains in mental health are still under debate in the literature. There is some evidence however that MVPA, 10 to 30 minute bouts, and resistance training (Chan et al., 2019; Gerber et al., 2013) may be some of the more beneficial characteristics of activity aimed at contributing to mental health. Overall, there is truly a plethora of evidence that all points heavily to the fact that PA generally is hugely beneficial for depression.

Research continues to reveal further activities which might benefit the mental health of young adults specifically. For example, one observational study found that movement such that young adult women accumulate greater than 7500 steps in a day was associated with approximately 50% less prevalence of depression, with non-significant mental health benefits for men as well (McKercher et al., 2009). Another 10-year longitudinal study found that young adults with moderate to high cardiorespiratory fitness showed an overall better ability to cope with stress (Gerber et al., 2013). Such findings are encouraging in that they suggest that diverse forms of PA can be beneficial for mental health. As such, individuals may have better shot at finding something enjoyable which has the potential to benefit long-term maintenance (Rhodes, 2014). Ongoing research into the mechanisms of PA for depression continues presently (Kandola et al., 2019), with more knowledge around the types of activities beneficial for MDD likely to emerge.

1.4.2 Levels of PA Participation Among Individuals with MDD

Understanding any potential modification to natural patterns of daily PA in the population with MDD is important to public health promotion efforts. The first-ever systematic review and meta-analysis of actigraphy and depression by Burton and colleagues (Burton et al., 2013) found that the commonly held clinical view that individuals with depression are affected by psycho-motor delay or agitation is likely correct. Results from 16 observational studies suggest that individuals with depression on average do less daytime activity and have significant increases in night-time activity. Interestingly, one cross-sectional study assessing PA in association with the severity of anxiety and depression symptoms found no significant association between threshold levels of depression and PA (Helgadóttir et al., 2015). However, the authors did find a pattern of steadily decreasing PA in accordance with symptom severity. Studies since have supported these findings, and provided some important illumination of the potential associations between PA and levels of depression. One seminal 6-year long observational study by Hiles and colleagues (2017) investigated patterns of change in PA associated with states of depression. They posited that there appears to be a "mutually reinforcing, bidirectional relationship between psychopathology and lower PA, particularly low sports participation" (p. 1466). While they found no significant relationship between MDD diagnosis and activity levels, an increasing severity of either depressive or anxiety symptoms did share a significant association with decreased sport and general PA participation. Interestingly, the authors also "observed relatively consistent evidence that psychopathology at one assessment was associated with enduring negative effects on activity indicators 2 years later" (p. 1473). While little research has focused directly on the challenge of parsing out the potential bidirectional relationship between PA and

MDD, it is evident that disruptions in PA behaviour are present in association with depressive symptoms.

1.4.3 Barriers to PA Participation Among Individuals with MDD

The decline in PA associated with the onset of depressive symptoms is not surprising considering the significant and numerous barriers to participation for individuals with MDD. Literature on this topic is rich and has been explored from a variety of perspectives (Firth et al., 2016; Glowacki et al., 2017). One review on this topic by Vancampfort and colleagues (Vancampfort et al., 2015) suggests that the major barriers highlighted by 59 studies involving patients with depression include "higher body mass index, the presence of physical co-morbidity and a lower self-efficacy" (p. 210). A systematic review and meta-analysis by Firth and colleagues (Firth et al., 2016) found the most prevalent barriers to be low mood, stress and lack of support. The barriers to PA for individuals with depression was reviewed again in 2017, with similar findings (Glowacki et al., 2017). Importantly, Firth and colleagues (2016) discussed how many of the most desirable outcomes sought through PA are inversely related to highlighted barriers, which ultimately restricts participation in this population. A large number of studies on barriers to PA for individuals with depression or mental health illness have revealed a significant number of diverse barriers.

The barriers to PA for individuals with mental illness certainly pose huge challenges for PA promotion. Glowacki and colleagues (2017) recommended that emotional determinants of health be considered for incorporation into intervention models for PA promotion. This was considering the emphasis that patients with depression placed on this particular barrier to PA. Relatedly, an important qualitative

study by Graham et al. (Graham et al., 2013) revealed through focus groups how definitions of healthy living can be more broad for individuals with mental health challenges. Rather than viewing health through the "narrow medical paradigm of exercise and diet" (p. 217), their participants highlighted the importance of "friendship, affordable safe housing, having employment, spiritual and emotional good health" (p. 217) in addition to exercise. Similarly, Vancampfort and colleagues (2015) posit that the "role of social, environmental and policy factors on PA participation is unknown and should be addressed in future research" (p. 210). Many avenues for PA promotion based on the barriers to PA for individuals with depression have yet to be explored, and should be considered if intervention approaches are to be improved.

1.5 Theory-based PA Interventions

1.5.1 Social Cognitive Behaviour Change Theories Applied to PA

The study of health behaviour change is still in its infancy, and the science continues to be developed at an expedient rate. The majority of health behaviour change theory has been developed in the past 40 years (Nigg & Jordan, 2005; Rhodes & Nasuti, 2011). During that time, dominant theories have developed, including theory of planned behaviour (Ajzen, 1991), social cognitive theory (Bandura, 1998, 2001) and many more. For example, specifically from 1990 to 2008 Rhodes and Nasuti (2011) found that environmental frameworks, social cognitive theory, and the transtheoretical model were the leading theoretical frameworks for psychology and PA studies. These theories accounted for 13, 7 and 4 percent of the study field respectively. Similarly, these same three theories dominated the intervention content of these same studies. Interestingly, "no theory" actually topped the list at 58 percent and 38 percent respectively of all theoretical frameworks and intervention content. Perhaps, this is given the fact that alongside the

development of behaviour change theory and intervention science has been criticism against these paradigms and the field itself.

Over the last decade in particular, new models of behaviour change and approaches to intervention have emerged to combat pitfalls and criticisms in the field of psychology and PA behaviour change. One major criticism is the lack of direct results from the reliance on activity intentions to ultimately impact health behaviour change overall (Rhodes, 2014). The majority of early social cognitive-based theories rely on intention alone to incite behaviour change; assuming that intention is the most proximal mediator for PA behaviour. Unfortunately, this assumption falls short in the real world, with at least half of subsequent behaviour left unexplained by the intention-behaviour relationship (Sheeran & Webb, 2016). As a result of this more recent criticism, the majority of researchers in health behaviour science have since argued to either augment (Rhodes, 2015; Rebar et al., 2015) or retire this approach entirely (Adams & White, 2003). Some of those in favor of augmentation have developed new models of behaviour change which have been useful in relation to PA and psychology research.

Newly emerging social cognitive frameworks that account for the intention-behaviour gap and are successful in guiding efficacious behaviour change and intervention research include the Health Action Process Approach (Schwarzer, 2016; Sniehotta, Scholz, & Schwarzer, 2005), the Transtheoretical Model (Prochaska & Velicer, 1997) and the M-PAC framework (Rhodes, 2017), as examples. The Health Action Process Approach has recently been a very popular approach for clinical research related to PA, psychology, and chronic disease (Schwarzer et al., 2011). For example, a number of studies have employed HAPA to examine PA behaviour change in individuals

with schizophrenia and other mental illnesses (Arbour-Nicitopoulos et al., 2017; Kramer et al., 2014; Petzold et al., 2017; Petzold et al., 2019). A recent examination of this body of literature suggests that in terms of application in intervention studies HAPA outnumbers any other action process-based theory aiming to account for the intention-behaviour gap by approximately 10:1. Despite its popularity, a number of other augmented social cognitive models do exist, and function well in the health behaviour change realm. The two-level Transtheoretical Model and the Multi-Process Action Control framework are others which have been applied successfully, for example; to behaviour change in serious mental illness (Gorczynski et al., 2010) and young adults (Husband et al., 2019) respectively. While no theory has yet to or may ever perfectly explain complex processes related to human behaviour, the science continues to progress and explore challenging issues in the field. More theory-based research is absolutely necessary in order to better understand best approaches for health change and health interventions.

1.5.2 Multi-Process Action Control Framework

In broad terms, the M-PAC approach is a layered framework incorporating some of the most salient and evidence-backed behavioural constructs known to support PA adoption and maintenance (Rhodes, 2017). An earlier iteration, The Action Control Framework, was developed by Rhodes and deBruijn (2013) in an effort to simplify and summarize social psychological oriented evidence for the benefit of applied behavioural interventionists. M-PAC was established from this work as an emerging action control approach to PA that responded to the persistent intention-behaviour gap and evidence suggesting the importance of self-regulatory and automatic predictors (Rhodes, 2015).

The framework is depicted as a pyramid, where each of the three layers in the model build and stack upon one another (Rhodes, n.d.). The base level is labeled “Decide”, and incorporates reflective behavioural constructs including perceived enjoyment, capability, benefits, and opportunity. One step above is the “Endeavor” portion of the framework, which includes regulatory constructs including emotional and behavioural. Lastly, habit and identity are suggested to be important to the maintenance of PA behaviour in the “Sustain” section of the M-PAC framework. While the model does build, all of the associated constructs are postulated to be linked by reciprocal determinism. Overall, it is a dynamic, progressive and innovative schematic which can be used to support future health research initiatives.

The introduction of the M-PAC framework also included evidence-based recommendations for conceptually and empirically pure approaches to evaluating and supporting health behaviour promotion through unique and specific mediators of PA. Rhodes (2017) breaks down the majority of the prevalent and relevant constructs known to mediate PA behaviour. For example, perceived capability and perceived opportunity, and their overlap and distinctions are explored. The evidence relating to both constructs is reviewed in relation to self-efficacy—one of the most longstanding and significant mediators of PA. Perceived opportunity and perceived capability are explored as more distilled aspects of self-efficacy not confounded by motivation, and presented as being worthy of greater attention from researchers. Similarly, all of the M-PAC tenets are presented with a range of current and emerging evidence in support of their recognition and use in behaviour change science at present. Ongoing research related to a clean interpretation and evaluation of PA behaviour change and promotion based on M-PAC

(Lithopoulos et al., 2022) continues, and new evidence is regularly considered for incorporation into this living framework. Overall, a growing body of empirical and observational evidence supports the significant unique and collective roles the M-PAC constructs play in determining health, and particularly PA, behaviour (Rhodes et al., 2021).

M-PAC framework has been beneficial in understanding the experiences of a number of populations and complex health issues related to this current study. For example, one recent study by Husband and colleagues (Husband et al., 2019) was applied to young adults between the ages of 18-25. Results indicated that the PA intervention, designed and evaluated considering M-PAC framework, was highly acceptable for the sample. This is very encouraging considering relevance of the research questions, intervention content and sample demographics. Another study by Trinh and colleagues (Trinh et al., 2020) evaluated the feasibility of a PA plus counselling intervention for prostate cancer survivors. They found that individuals in the PA plus behavioural counselling group, a condition based on the constructs of M-PAC, displayed improved adherence and acceptability over PA plus standard exercise counselling. Furthermore, results from the analysis of secondary outcomes also favored the M-PAC-based counselling on measures including quality of life and objectively assessed MVPA. Unfortunately, to the author's knowledge, M-PAC has yet to be applied in intervention studies involving patients with MDD. That said, it is encouraging to see such favorable outcomes in chronic disease populations that might experience related barriers to health promotion. One study which aimed to evaluate differences in health belief based on mutually exclusive chronic health diagnoses found more similarities than differences in

the way that disease diagnoses interact with PA behavioural beliefs (Rhodes & Blanchard, 2007). As such, considering evidence from other chronic disease populations may be a helpful lens from which to consider theoretical foundations for this present study. There is certainly still much to understand about the explanatory and functional ability of M-PAC framework to guide mental health chronic disease research, but related studies to-date are promising.

1.5.3 Behavioural Correlates of PA for Patients with Mental Illness

Models applied to understand PA engagement among individuals with mental health illness and MDD, in some cases, have drawn similar conclusions, suggesting various stages of engagement where unique constructs interact with PA intentions and behaviour. While the literature specific to mental health populations is quite limited, and those specifically applied to MDD populations even more so, some trends within these stages are already visible. Amongst primary studies in the general mental health field, there appears to be a clear distinction between motivational constructs and their link to PA intentions, and volitional constructs and their link to PA behaviour (Arbour-Nicitopoulos et al., 2017; Gorczynski et al., 2010; Kramer et al., 2014; Petzold et al., 2017; Petzold et al., 2019). Illuminating these types of associations can be hugely beneficial to better understand barriers to the challenging process of PA engagement and ultimately adherence for individuals with mental illness and/or MDD.

It is reasoned that given the unique barriers individuals with mental illness face, the motivational stages of PA behaviour change are most strongly correlated to PA intentions, and subsequent behaviour (Kramer et al., 2014). Empirical studies framing PA intentions and behaviour within HAPA constructs have mostly found significant

moderate to high Cohen's d effect sizes linking outcome expectations, action self-efficacy and sometimes goal setting constructs to intention (Arbour-Nicitopoulos et al., 2017; Arbour-Nicitopoulos et al., 2014; Kramer et al., 2014; Petzold et al., 2017; Petzold et al., 2019). One observational study with results in support of these findings was conducted by Gorczynski et al. (2010). These researchers shared supportive evidence for the distinction of various pre- and post-intentional (termed pre-contemplational and contemplational) stages of PA behaviour change based on the bi-level Transtheoretical Model. Furthermore, they indicated significant associations between action self-efficacy, and outcome expectations and action approach. These findings are quite logical considering what we know about self-efficacy, motivation and intentions in the general population.

Of note in studies specifically examining behavioural correlates of PA for individuals with mental health illness are constructs which have begun to trend towards being consistently insignificant. Interestingly, risk perceptions were non-significant to PA intentions in all of the aforementioned empirical studies, some of which included individuals with MDD (Arbour-Nicitopoulos et al., 2017; Arbour-Nicitopoulos et al., 2014; Kramer et al., 2014; Petzold et al., 2017; Petzold et al., 2019). It has been reasoned that given the number of comorbid chronic risk factors already afflicting individuals with severe mental health illness in particular, perhaps risk perceptions might carry less weight (Arbour-Nicitopoulos et al., 2014). Furthermore, Kramer and colleagues (2014) also suggested that outcome expectations, particularly affective attitudes, could be considered for potential removal in future interventions with depressed individuals. It may have limited practicality for individuals facing challenging depressive symptoms. Patients in

the study by Kramer and colleagues were reportedly “unimpressed” (p. 1209) with the construct of outcome expectations. This perhaps highlights its’ off-putting or dysfunctional nature for individuals whose symptoms could directly impact their ability to feel optimism for the future. Relatedly, goal setting has been inconsistently incorporated into pre-intentional research evaluations. While it has shown moderate significant correlations to PA behaviour intentions (Petzold et al., 2017; Petzold et al., 2019), further study is needed to understand its relation to PA behaviour. Overall, significant associations between most motivational constructs and PA intentions, and subsequent behaviour have been determined in studies involving a number of different mental illness diagnoses.

While motivational constructs appear to be most closely associated with PA intentions and behaviour in individuals with mental illness, volitional constructs are still reported to be important factors in establishing lasting PA behaviour for this population. Volitional constructs are certainly less explored in PA interventions with mental illness moderators. To the author’s knowledge not a single empirical study has investigated all of the most common volitional constructs together at one time. That said, volitional factors investigated to some degree in relation to PA behaviour change in individuals with mental illness to-date include maintenance self-efficacy, social support, action control/self-monitoring, recovery self-efficacy, action planning and coping planning (Arbour-Nicitopoulos et al., 2017; Arbour-Nicitopoulos et al., 2014; Kramer et al., 2014; Petzold et al., 2017; Petzold et al., 2019). From these studies it is evident that volitional constructs appear to be less associated with PA behaviour in mentally ill populations. Cohen’s d effect size interpretations for all of the aforementioned volitional constructs

have ranged in various study reports from small to moderate, with mixed results in terms of significant associations with PA behaviour outcomes. Specifically, with an MDD sample, Kramer and colleagues (2014) investigated the constructs of maintenance self-efficacy, action control, action planning and coping planning. They determined that all were related to the outcome of PA levels. In particular, action control and action planning were significantly correlated to levels of MVPA. Current evidence provides some beneficial insights, but also warrants future study to better distinguish the roles of motivational and volitional constructs on PA behaviour change for individuals with depression.

1.5.4 Efficacy and Effectiveness of Theory-Based PA Interventions for MDD

Theory-based PA interventions tend to employ behaviour change techniques (BCTs) which can benefit study outcomes. In a recent review, McEwan et al. (McEwan et al., 2019) found that 148 theory-based PA interventions had an average effect size of $d = 0.48$ in comparison to 77 non-theory-based PA interventions with an average effect size of $d = 0.37$. While this difference was non-significant, it does suggest some trend towards successful theory-based interventions over non-theory-based ones. Based on further findings by McEwan et al. (2019) it is suggested that the informed and intentional use of BCTs can impact the success of interventions. Studies which employed at least three BCT clusters (Michie et al., 2013) had significantly larger effect sizes in comparison to those that included less or none at all (McEwan et al., 2019). While non-theory-based interventions may incidentally include a number of BCTs from various clusters, using theory to guide this process can inform intentional development of intervention approaches which aim to be more efficacious or effective. With this

evidence in mind, the inclusion of theory to intervention studies can certainly benefit study outcomes.

Theory-based intervention approaches to PA treatment of MDD have been extremely limited, but successful when applied. Considering, as mentioned previously, that PA has only recently been recommended as a behavioural treatment for MDD (Ravindran et al., 2016), research continues to develop in this area. Much of past research up until recently has been focused on determining whether PA is effective as treatment for MDD (Schuch et al., 2016), as opposed to using theory as an aid to determine optimal protocols and intervention strategies that also consider engagement and adherence. Those studies that do have obviously stated theoretical foundations are frequently observational studies assessing levels of the correlates of PA in individuals at various stages of change (Gorczynski et al., 2010; Kramer et al., 2014). One recent intervention study using obvious HAPA theory examining the effects of a PA intervention for individuals with various mental health disorders (including schizotypal, mood and anxiety disorders) found a significant increase in objectively measured PA (Petzold et al., 2019). The change in self-report PA was non-significant, but did show a trend towards improved activity levels with the intervention. Unfortunately, these researchers were limited in being able to report on the mental health outcomes of the study given that the PA and "control" groups both received some form of intervention. To the author's knowledge, this is one of the only theory-based PA intervention studies with a sample of MDD patients that hasn't been based online. There is a clearly a dearth of studies investigating PA and MDD from an obvious theoretical foundation.

1.5.5 Online PA Interventions for Adults with MDD

Online PA interventions can offer a lot of what MDD patients have specifically highlighted as important to them, while avoiding some of the common pitfalls of face-to-face programmes. One of the most obvious benefits is the accessibility that online interventions can potentially provide. Recent reports suggest that over 85% of Canadian households have access to the internet (CBC News, 2015). While disparities are prevalent based on education and socioeconomic status (Haight, Quan-Haase, & Corbett, 2014), the vast majority of Canadians will have some form of access to the web. This level of in-home accessibility is especially important for individuals with MDD who may struggle with energy levels and anhedonia, which can impact one's ability to make it to meetings, groups, or exercise classes generally associated with typical therapeutic programmes. Furthermore, participants in past PA for mental health interventions and qualitative investigations have explicitly stated the importance of aspects such as social support, a sense of purpose and achievement, identity, and facilitating personnel (Glowacki et al., 2017; Mason & Holt, 2012). All factors which can be easily incorporated into tailored online content that is convenient.

Recent online PA interventions applied to MDD populations have been incredibly successful at reducing depression severity. Three recent RCTs, all employing online, theory-based modular interventions aimed at increasing levels of PA, reported considerable beneficial changes in depression severity (Lambert et al., 2018; Nyström et al., 2015; Strom et al., 2013). All three studies reported significant negative correlations between their intervention condition and depression severity. Remarkably, Lambert and colleagues reported within their PA intervention group 56% of participants experienced a decline in PHQ-8 symptoms to the point that they were considered sub-threshold (i.e.,

remitted) for MDD. Furthermore, recent pilot and feasibility trials of online PA interventions for MDD patients lend support to these findings. Kerr and colleagues (2008) and Mailey and colleagues (2010) showed negative correlations between their intervention groups and depression status. Notably, Kerr and colleagues reported that 40% of patients had reduced their PHQ-9 scores by at least 5 points. These are truly noteworthy outcomes to suggest that online interventions can be effective avenues of care and treatment for patients with depression.

These same online PA interventions for MDD have been successful on a number of other outcomes, including acceptability. Some measure of one or more of feasibility, acceptability and fidelity were reported by (Kerr et al., 2008; Lambert et al., 2018; Mailey et al., 2010). Each had good ratings on these factors. Overall retention ratings ranged from 62% in the feasibility trial by Kerr and colleagues (2008) to 92% in the RCT by Nystrom and colleagues (2017). Recruitment and retention were considered relatively good in each of these studies. Acceptability was often mixed, but the majority of participants in all three studies found the interventions acceptable. For example, participants in the study by Kerr and colleagues reported 70% acceptability, with more than 60% completing more than half of the lessons. Lambert and colleagues reported that 62% of their participants generally rated being “Very satisfied” or “Mostly satisfied” with all aspects of the intervention. Each study certainly reported individual areas which could be improved in future iterations of the study, but overall, these indicators of acceptability were all quite good.

Secondary health outcomes for patients with MDD including anxiety and quality of life (QoL) have been seen to benefit from online PA interventions. Lambert and

colleagues (2017) reported decreases in anxiety scores both within the intervention group and in favor of the intervention versus control group. Similar effects for anxiety were seen by Nystrom and colleagues (2017), Strom and colleagues (2013) and Mailey and colleagues (2010). Additionally, both Kerr and colleagues and Strom and colleagues investigated two different measures of QoL. They found Cohen's d effect sizes for their treatment groups ranging from 0.56 to 0.36 respectively, though these findings either could not be assessed for or only approached significance. Such findings suggest that online PA interventions have the potential to benefit a multitude of outcomes across various dimensions of health. Considering the prevalent risk of comorbidities individuals with MDD face, these findings are of the utmost relevance and meaning.

1.5.6 Integrated PA Interventions in Multidisciplinary Team-Based Mental Health Care

Considering the number of barriers individuals with mental illness face when it comes to accessing, establishing and maintaining treatment, community integrated mental health care has the potential to be a powerful and sustainable approach. One study examining the feasibility of a community avatar-based PA and health behaviour support program for individuals with major depression identified integration as a major concern of participants (Burton et al., 2012). Another study by Hodgson and colleagues (Hodgson, McCulloch, & Fox, 2011) took a qualitative approach to examine integrated PA programmes for individuals with mental illness from their perspective. Their findings suggested that such programmes were perceived as beneficial in multiple ways, important tools for engagement in ongoing care, and effective at helping individuals to overcome significant barriers to care. The authors also highlight how an enabling factor for these individuals was supportive mental health staff. This is understandable, considering the

well-established importance of the therapeutic alliance (Battaglia, 2019; Johansson & Jansson, 2010), sometimes referred to as the working alliance in physiotherapy and exercise contexts (Vestøl et al., 2020). The level of integration of newly emerging adjunct clinical programs has clearly been highlighted in the literature as both a barrier and priority for accessible, acceptable care.

Despite recent evidence demonstrating the need for integrated programs for mental health care, such programs continue to be few, underutilized, and lacking longevity. For example, the Mood Disorders Association of British Columbia (MDABC) offers an adjunct PA intervention for individuals with depression in BC known as Jump Step (MDABC, 2021; Sims-Gould et al., 2017). To the author's knowledge, this is one of the only programs advertised in BC for patients with depression, and while accessible (i.e., no doctor's referral required) it lacks integration. Lederman and colleagues (2017) highlighted this gap in integrated behavioural treatment approaches in their recent article. The authors suggest a number of solutions for such gaps. These included collaboration with university exercise science programs, ongoing community-based feasibility and acceptability studies to "build a greater understanding of what works in real-world clinical settings" (p. 454), and service-user engagement. Furthermore, Lederman et al. recommended multidisciplinary approaches "including mental health and allied health team members, family and carers" (p. 454), evidence-based behaviour-change strategies, and the involvement of exercise professionals for appropriate participant supervision as best practice for integrated community clinical behavioural programs. It is suggested that the implementation of evidence-based factors to assist with PA intervention integration in

mental health service systems will contribute to momentum, and ideally increased engagement and accessibility for patients with depression.

1.6 Overview of Research Objectives

The main objectives of this research were to: 1) iteratively adapt and target an existing online intervention using M-PAC framework (Rhodes, 2017) based on feedback from youth aged 19-30 with experience of low mood and/or depression who participated in online, semi-structured interviews, and to 2) evaluate the feasibility of the adapted beta-intervention compared with a waitlist control in a randomized, pilot intervention trial. These objectives were explored through two related studies. Study one is reported in chapter two, and study two in chapter three of this manuscript. Discussion based on both study one and two findings together, including limitations and considerations for future research, are presented in chapter four.

Chapter 2 Study 1

A Qualitative Study Using Brief Interviews for the Development of a Beta-Online Physical Activity Intervention Platform for Individuals with Low Mood and/or Mild to Moderate Depression

Abstract

Background: Online, theory-based, physical activity (PA) interventions are emerging as efficacious approaches to improve PA and a number of mental health outcomes among young people with depression. Unfortunately, little is known about population specific factors which impact the feasibility and optimization of such interventions. The aim of this study was to investigate, through brief online interviews, perspectives of an existing online PA intervention. **Methods:** Participants were individuals aged 19-30 with experience of low mood and/or depression residing in British Columbia. The semi-structured interview comprised of a brief overview of the intervention, plus an opportunity to engage with the online platform before participants were asked a series of questions related to feasibility. A continuous, qualitative, reflexive thematic analysis was conducted by the author. **Results:** Four major themes plus 11 subthemes were identified that aligned with acceptability, demand, practicability, and integration. Overall, participants (N=7) reported very good acceptability, demand and practicability, while few participant comments were made regarding integration. A number of important change ideas were raised by participants, including adding a component of social support among intervention participants, and providing participants with more structured PA supports. **Conclusions:** Importantly, limitations of this research include a relatively short period of engagement with the intervention for participants to base their feedback on, as well as the narrow scope of participants' feedback. Ultimately, this study resulted in six distinct

changes to the intervention platform as recommended by interview participants relevant to themes of acceptability, demand and practicality, thus emphasizing the importance of seeking fulsome stakeholder feedback and integrating this into promotion approaches whenever possible.

Introduction

Depression is a mental illness which not only impacts aspects of daily living like mood, energy and focus, but a wide array of health behaviours and well-being. Depression will affect about 3 million or 11.3% of Canadians during their lifetime (Pearson et al., 2013). Canadian young adults report the highest annual prevalence of depression. Young people globally report that depression causes them the most significant disease burden compared to any other illness (Gore et al., 2011). While pharmacotherapy is the leading first-line treatment (Lam et al., 2016), there are a number of longstanding issues with this approach including treatment of mild and sub-threshold depression, poor medication adherence, adverse side effects (Popa-Velea et al., 2014). As such, there is ongoing investigation into alternative and complimentary therapies, which have continued to gain in popularity (Lam et al., 2016).

PA has recently been recommended "as first-line monotherapy for mild to moderate [depression] and as second-line adjunctive treatment for moderate to severe depression" (Ravindran et al., 2016, p. 579). A considerable amount of evidence, consisting of systematic reviews and meta-analyses, demonstrates reliable moderate to large effects of PA on depression outcomes among youth and young adults (Cooney et al., 2013; Danielsson et al., 2013; Krogh et al., 2011; Rosenbaum et al., 2014; Silveira et al., 2013; Stanton & Reaburn, 2014; Stubbs et al., 2016). For example, Rosenbaum and

colleagues (2014) determined a large effect for PA on depression based on their meta-analysis of 20 studies featuring a variety of exercise modalities and intensities. PA broadly has been determined to be quite effective for reducing the symptoms of depression.

Despite this understanding, there is a serious lack of participation in PA. Approximately two-thirds of adults with depression do not, on average, achieve recommended PA levels (Schuch et al., 2017). Furthermore, individuals diagnosed with MDD have been seen to experience subsequent declines in PA levels (Hiles et al., 2017). Some evidence has indicated that this may be due to motivational deficits for activity associated with depression (Mailey et al., 2010). Regardless of the mechanism, these trends are especially concerning given that activity levels in the general population without MDD are already low (Ross et al., 2020). Appropriate strategies to improve PA participation among those with depression are needed.

Theory-based, PA interventions can be efficacious for improving PA levels among clinical mental health populations, particularly young people with depression. In their systematic review and meta-analysis, Romain and colleagues (Romain et al., 2020) found that motivational theory-based (including social cognitive theory) interventions were effective at increasing PA among adults with mental illness including depression (g = 0.27, 95% CI [0.03; 0.51], p = .003). Interestingly, larger effect sizes were seen among those interventions which included only one theory and correlational analyses failed to indicate any superiority of particular BCTs for intervention effectiveness. Altogether, these findings are comparable to those determined among the general population also highlighting the importance of intentionally designing PA interventions based on theory

(McEwan et al., 2019). More specifically, Mailey and colleagues (2010) study supports the efficacy of social cognitive theory-based PA interventions among young people with depression. They found larger increases in PA among the intervention group (d=0.68) versus the control (d=0.05), and correlations between PA and exercise self-efficacy (r=0.62). While more evidence is needed to better understand relationships between various theoretical approaches and PA and depression outcomes specifically, theory-based interventions are proving to be efficacious for this population.

Online PA interventions are one approach drawing an increasing focus from researchers given their potential to bolster health promotion efforts in novel and innovative ways. Findings from web-based intervention research has begun to accumulate, with trends in results demonstrating comparable efficacy to that of traditional, in-person approaches (Mohr et al., 2013). Evidence is also growing in support of the efficacy of online PA interventions for individuals with depression (Kerr et al., 2008; Lambert et al., 2018; Mailey et al., 2010; Nystrom et al., 2017). For example, young adult participants have shown improvements across a number of mental health outcomes including levels of depression and perceived quality of life (Kerr et al., 2008; Mailey et al., 2010). These approaches also offer additional benefits like improved access to mental health care for many, including rural residents (Mohr et al., 2013).

Despite the many successes and advantages of online PA interventions for youth with depression, there is still much to understand about online approaches. To date, the majority of the online intervention studies involving participants with depression have focused little on the evaluation of the intervention itself (i.e., technology, materials, tools). For example, Strom and colleagues (2013) and Nystrom and colleagues (2017)

included no measures related to feasibility. Alternatively, Kerr and colleagues (2008) and Mailey and colleagues (2010) both included a brief quantitative process evaluation. While these latter evaluations do provide some evidence for outcomes like acceptability, it provides little in the way of rich participant feedback with enough detailed coverage to apply to future studies. As such, it can be challenging to understand design strategies to bolster future feasibility, including outcomes like adherence and acceptability, in light of past research. Thus, there exists a large gap in understanding in order to properly integrate technology with future intervention delivery.

One approach to bridging the gap in understanding regarding technology-based health interventions is to take up a rigorous, iterative development process, like that outlined by the Integrate, DEsign, Assess, Share (IDEAS) framework (Mummah et al., 2016). Mummah and colleagues propose IDEAS as a framework which improves on past models and frameworks by "more fully integrat[ing] strengths from behavioral theory, design thinking, and evaluation" (p. 3). Importantly, IDEAS has a relevant focus on guiding intervention technology development in a way that emphasizes behaviour change. Given this focus, IDEAS has been applied quite extensively and with success in a variety of web-based health behaviour interventions, including some PA-based (e.g., Hartson et al., 2022). In this way, IDEAS can be considered a focused, evidence-based and efficient guide.

A leading tenet of IDEAS is to ground the development of the technology-based intervention in behavioural theory. As such, this study draws from considerable research investigating social cognitive predictors of PA-- the leading theoretical approach in PA intervention research (McEwan et al., 2019; Rhodes, McEwan, & Rebar, 2018). In

particular, action process theories have been proposed as a contemporary approach to tackle longstanding gaps in the explanatory power of traditional social cognitive models applied to PA behaviour and intervention science. Gaps that include prevalent phenomenon like the “intention-behaviour gap” (Rhodes, 2017), which often can not be fully explained by more traditional social cognitive models such as Azjen’s theory of planned behaviour (1991). Multi-Process Action Control framework (M-PAC) is one approach proposed to address such challenges by bringing together the most salient constructs explaining variance in activity intention formation, as well as translation to activity behaviour (Rhodes, 2017). M-PAC has been applied in recent, novel intervention research to better understand PA behaviour in a number of populations (e.g., University students, cancer patients, newly retired) with some beneficial outcomes (e.g., Hollman et al., 2020; Husband et al., 2019).

More recently, M-PAC has been developed into a self-guided, web-based, 10 lesson intervention to promote PA (Liu et al., 2019). Of note from this research, Liu and colleagues employed the IDEAS framework in their development of the intervention, and commented in their report on the importance of further effectiveness testing. Efficacy trials involving the M-PAC online intervention have since been conducted. For example, Hollman and colleagues (2022) applied the 10-lesson intervention (with minor targeting) and found high recruitment, retention, usability and acceptability among new moms. Despite these findings, participants also shared constructive feedback with respect to acceptability. This feedback centered particularly around the targeting and optimization of the online intervention. All of this evidence may suggest that while M-PAC framework shows early promise implemented as a web-based intervention, future iterative trials

continuing with the IDEAS framework may be warranted to build on the successes of this approach so far.

This qualitative study aimed to integrate fulsome end-user interview feedback as part of “Integrate and DEsign” stages of the IDEAS framework (Mummah et al., 2016, p. 3) to better design, target and implement an adapted version of an existing M-PAC online intervention (Liu et al., 2019; Rhodes, 2017). While some qualitative research exists on intervention feasibility (including usability) among depressive samples, the body of evidence is quite small and often removed from existing products and ongoing trials. For example, Sims-Gould and colleagues (2017) conducted a large-scale qualitative study among adults with depression exploring facilitators and barriers to PA, as well as what an ideal intervention for these participants might generally entail. Although this study contributed important information on specific predictors of PA among clinical mental health populations, any connection to existing interventions or trials was lacking. There is a need for more extensive qualitative research exploring alternative approaches to mental health care and treatment that integrates with ongoing behavioural health research as a means to optimize intervention design and implementation.

The importance of integrating qualitative research within the context of applied intervention science has been repeatedly highlighted. Further argument and support for this approach is offered by Bowen and colleagues (2009) framework of "Areas of Focus” (p. 453) for feasibility studies. The framework provides a series of eight areas of focus which can easily be incorporated into qualitative research materials with the aim of exploring user feedback from an applied lens. In fact, Bowen and colleagues explicitly provide suggestions in their article of qualitative designs which might best address each

of the areas of focus. They argue for including stakeholders in meaningful ways in the early conceptualization and design of feasibility research. As such, employing a relevant framework such as this can help to improve the organization of qualitative data collection, maintain cohesive focus across various stages of inquiry and study, and aid future replicability.

The aim of this study was to understand perspectives of young adults with experience of low mood and/or depression on factors related to the feasibility of an action control theory-based online PA intervention. This study was one component of an ongoing feasibility trial following the IDEAS framework. Qualitative research questions and the interview guide were formulated using Bowen and colleague's framework featuring areas of focus for feasibility studies. Participant feedback was integrated as part of an iterative intervention design process.

Research Questions.

1. Is the existing online intervention platform, and all of the associated lessons, content, and Behaviour Change Techniques (Michie et al., 2009, 2013) in their current iteration, acceptable, in demand, practical, and appropriately integrated specifically for young adults with experience of low mood and/or depression?

2. What, if any, modifications to the existing online intervention platform's lessons, content, or associated Behaviour Change Techniques might be suggested to better meet these outcomes and benefit the population of interest?

3. What, if any, are the salient concerns or comments from the population of interest with respect to the PA intervention overall?

Methods

This study was conducted between May and December of 2021 in British Columbia, Canada. An ethics proposal was approved by the University of Victoria Human Research Ethics Board (ID#21-0237).

Design.

This qualitative study entailed one-time, virtual, and semi-structured interviews.

Participants.

Eligible participants were individuals: (1) between the ages of 19-30 years, (2) who self-identify as someone with experience of depression (ranging from low mood and/or depressive symptoms to a formal mild to moderate Major Depressive Disorder diagnosis according to the DSM-V), (3) living in British Columbia (4) fluent in English, (5) with access to a computer with an internet connection, and (6) access to a private space where they can confidentially share in an interview. Exclusion criteria included: (1) anyone self-reporting/identifying with severe or unmanaged depression, (2) anyone identifying with perhaps a related mental illness (e.g., anxiety), but not specifically depression or depressive symptoms, AND (3) those who are identified by Foundry Victoria Youth Clinic staff or researchers as in crisis at any point throughout the study.

Participants were recruited between September and December of 2021. A number of recruitment methods were used. Staff at Foundry facilitated some recruitment among clients ages 19-25 being seen at their clinic, and their community at large. Posters were put up at the clinic, social media advertisements were shared on the clinic's Instagram account, and clinicians were provided with study information they could share with potentially eligible youth being seen one-to-one in medical appointments. No recruitment

was conducted in groups in order to ensure the privacy of patients. Additional recruitment was conducted outside of the clinic across British Columbia, primarily through social media. Advertisements were placed on Facebook and Instagram through the University of Victoria Behavioural Medicine Lab's profiles on these sites. Recruitment was rolling until the researcher felt that a meaningful and pragmatic engagement with the population of interest had been achieved (Braun & Clarke, 2019a; Fusch & Ness, 2015).

Procedures.

Youth interested in the study reached out to the research coordinator independently. Those potential participants in contact with the study coordinator received more information regarding the study in the form of an email, including a consent form and a pre-interview questionnaire. Email communications, and a completed and returned questionnaire were used to screen youth for eligibility. Interviews were conducted one-to-one with each participant and the research coordinator over a 30-40-minute period hosted on Zoom at a mutually convenient time. The interview featured brief introductions, a 10-minute overview of the intervention including a screen share of the online alpha-platform. Following this, participants were asked a series of six semi-structured interview questions and provided with approximately 15-25 minutes to provide their feedback.

Instrument.

An interview script was developed using Bowen and colleagues (2009) "key areas of focus for feasibility studies and potential outcomes" (p. 454). A subset of the key areas of focus were chosen to frame the Interview Guide based on the phase of research, relevance to youth who would be participating in the study, as well as practicality given resources and time. A total of six interview questions were included in the guide, with

two to five minutes allotted for feedback per question. A complete list of interview questions can be found in Appendix A. Additionally, a table mapping the selected Bowen and colleagues' (2009) key areas of focus to the interview questions can be found in Appendix B.

Intervention.

In brief, the intervention as described to participants was originally designed as a 10-week long, PA promotion program. The alpha-platform featured 10 theory-based modules or lessons developed according to the Multi-Process Action Control framework (Rhodes, 2017). These lessons in order were: (1) the physical benefits of PA, (2) the mental benefits of PA, (3) increasing self-confidence for PA, (4) learning about your emotions (5) building social support, (6) building PA opportunity, (7) goal setting and planning (8) self-monitoring, (9) habit, and (10) identity. The lessons featured a variety of content including text, short (2-5 minute) videos, poster-like visuals and graphs. The lessons had a common structure–Read, Reflect, and Recap sections. In this way, the intervention was designed to have participants review one lesson per week where they would learn about the lesson topic, participate in some reflective activities, and lastly, receive a point-form overview of the lesson and have a chance to solidify their learnings by taking a short quiz. Participant progress through the online platform was automatically logged by the site and visualized on a progress bar. A number of additional features were built into the alpha-platform. These included an Introduction page where participants could learn about how to navigate the platform, an At-Home Exercises tab with access to a customized YouTube channel with at-home, all-levels, and equipment-free exercise classes, and a My Diary tab where participants could see all of their reflective activities

and goal setting that they might log throughout the various lessons of the program summarized on one webpage.

Additional procedures associated with the planned intervention trial described to interview participants were weekly emails and a mid-way check-in. Participants of the intervention would receive weekly emails from the research coordinator providing an overview of the lesson topics for the week, a reminder to login and complete PA, and the ability to respond for one-to-one support from the research coordinator as needed. Also included was an optional 30-minute Zoom call one-on-one between each intervention participant and the research coordinator at approximately the mid-way point of the intervention. It was suggested that this might provide participants the opportunity to raise any questions about the intervention, receive individual exercise coaching from a certified fitness professional (i.e., the research coordinator), or partake in more casual social support.

Data Collection and Analysis.

Data collection was conducted using the University of Victoria's Zoom platform for video conferencing. Interviews were recorded using the platform and stored locally on University of Victoria servers. Audio files were transcribed verbatim, and all identifying participant information was removed. Transcripts were stored using participant identification numbers. Completed transcripts were immediately uploaded to NVivo 12 Plus for analysis by the research coordinator.

A continuous, reflexive thematic analysis (Braun & Clarke, 2019b, 2020) was employed for this study. This method was selected given the inherent flexibility for both inductive and deductive coding based on participants' responses as well as the chosen

theoretical approach. Importantly, reflexive thematic analysis also can be performed by a single researcher. The analysis was in keeping with a critical realist epistemology (Roberts et al., 2019). In this way, each interview was carefully transcribed and checked for errors, and immediately loaded into NVivo for ongoing coding and analysis. Each transcript was read over a few times by the coding researcher, as a means to become familiar with the data. Next, transcripts were freely coded once through in NVivo. Once all six interviews had been loaded and freely coded once, themes and subthemes were produced given the data and alignment with the feasibility framework that was incorporated into the interview questions (Bowen et al., 2009). At this point, a coding structure of nodes and subnodes mirroring the identified themes and subthemes were loaded into NVivo. The researcher then engaged in a second round of coding using these tags. Continuing a reflexive approach, the author reviewed excerpts code-by-code, referring back to definitions for each of the key areas of focus and considering researcher assumptions. After this point, coding was considered complete

Results

Sample.

A total of 19 youth contacted the research coordinator regarding the study and were provided study information. Of those, nine young people followed up. A total of eight individuals were eligible and one was ineligible due to their age. One participant dropped out just prior to booking an interview citing time constraints. Altogether, a total of seven participants completed the interview in full, and their data has been anonymized, analyzed, and interpreted.

The average age of participants was 25 years old (*SD*=2). The majority (5, 71%) of participants identified as female, with all others male (2, 29%), and no diverse gender identities declared. The sample was otherwise diverse and educated. Five participants (70%) reported identifying with a non-Caucasian ethnicity. The majority (4, 57%) of participants had completed at least a Bachelors degree. Many participants elected not to provide information regarding salary; a representative income was unable to be calculated for this sample. With respect to PA levels, five (71%) participants in the sample were not meeting Canada Physical Activity Guidelines for adults (Ross et al., 2020) of 150 minutes of MVPA per week. Half of the sample reported a formal depressive disorder diagnosis. All of those participants identifying with one threshold level mental disorder reported at least one additional co-occurring mental disorder. Participant scores on the Patient Health Questionnaire-9 ranged from mild to moderate depressive symptoms. Just over half of all participants were impaired based on the Patient Health Questionnaire-9 Functional Health Assessment. A total of four (57%) participants reported that they were in good health compared to peers their age, however there were also reports of poor (1, 14%) to fair (2, 29%) health.

Thematic Findings.

The study findings are organized according to the objective of exploring "the key areas of focus for feasibility studies" (p. 454) as described by Bowen and colleagues (2009). Four major themes were developed, including acceptability, demand, integration and practicability. A total of eleven sub-themes were also identified. This includes seven aspects falling operationally within the key areas of focus. Additionally, four sub-themes were created in order to identify change ideas shared by participants pertaining to each of

the four major themes. A complete summary of the thematic framework can be found in Appendix C. The coding researcher found good agreement between the selected themes and subthemes and participants' data. There were no outliers identified by the researcher. A synthesis of the identified themes and subthemes follows.

Theme 1: Acceptability.

Subtheme 1a: Satisfaction.

All participants spoke to their satisfaction with the overall intervention, including the platform, content and tools. A major strength that multiple participants mentioned was the organization of the intervention in the online platform. One participant stated that the intervention was, "extremely straightforward and well organized" (P01). Another participant commented, "I've never been someone who's, like been super excited about exercise. But I think that the platform is great. Like, it lays it out nicely" (P03). Participants expressed overall satisfaction with the intervention, but they also spoke to some specific features which they were particularly satisfied with. For example, Participant 4 said, "The user interface is quite clean, and it seems really intuitive as well. So, I don't see any issues with like… complications with using it, which is always a good thing. And then, yeah, I really like the format too… the graphics and the videos are like really good, essential things to have in there. I think that it just makes it look a lot more approachable" (P04). Not a single participant reported any dissatisfaction with the intervention as a whole.

Subtheme 1b: Positive Perceived Effects.

It was very interesting that many of the study participants made comments which suggested that they believed the intervention would support them to engage in various

Behaviour Change Techniques. For example, one participant shared that, “the little like, reflection box during each module was pretty helpful. Because then you have to self-reflect” (P01). Similarly, another participant commented, “the Reflect, Read, and Recap is great, because it actually like forces you to make sure that you're like reading through all the content. And making sure that you're actually taking it in” (P06). Importantly, a few participants spoke to certain lessons being particularly novel and beneficial to support them to understand their health. “Yeah, I think my favorite, I guess component of it is the learning kind of about, like, why we're doing exercise and learning about emotions. And like the increasing self-confidence, I feel that I've never really almost associated those two with exercise and fitness. So, I think that's really awesome that it's being incorporated” (P06).

Subtheme 1c: Fit Within Culture.

Participants reported excellent overall satisfaction with the intervention appropriateness for young adults with experience of low mood and/or depression. Some participants commented, “I think the wording all looks good” (P03). Others clearly reported the content to be appropriate, saying, “No I didn’t see anything [confusing, offensive, irrelevant or unimportant]” (P04), and, “No, nothing at all [confusing, offensive, totally irrelevant or unimportant]” (P06). While no aspect of the intervention was red flagged by participants, some specific content was highlighted as being a particularly good fit. “I think some people would maybe prefer watching videos because like, if they’re students they will probably be doing a lot of reading throughout their day already. And then it… maybe feels like more reading” (P06). Also, “I think it's great that like, we get to learn about why we have to exercise, because I feel like that's like a

missing component" (P06). Altogether, the mixed delivery of the intervention content and tools seemed to be a particularly good fit across all participants.

Subtheme 1d: Change Ideas.

There were a couple of common recommendations from youth to make the platform more appropriate for them. One idea being changes to graphical information shared on the intervention platform. While different ideas were presented with regards to how graphs might be changed, it was clear that the graphical information was less accessible for multiple participants. "I guess maybe one thing is the graphs, I feel like maybe some people might just look over them. Like, I know for me, sometimes if I see graphs I'll just like skip. There's just like, there's a lot going on. It can be kind of overwhelming. I guess different people have different experiences looking at and being able to read graphs" (P06). Another comment was, "I think just having eye catching things… [there were a] couple of graphs that were like in black and white" (P03). Additionally, participants were understandably very intrigued by the second lesson on the mental benefits of PA, and some commented that this might be a more engaging lesson to open the intervention with. One participant commented, "I think the position I was gonna make was to flip the first and second lesson plan… I think that if you're targeting people, specifically who have low mood, they might want to learn about the mental benefits of it first, because I… feel like a lot of people will like skim through [the first lesson] because most people know in general it's gonna make you healthier, right. Like, those are great, fun facts. But… that's not the issue for most people… so yeah, I think for me it would be more interesting to see the mental side first" (P03).

Theme 2: Demand.

Subtheme 2a: Interest.

Encouragingly, participants reported a considerable interest in the intervention overall. Some comments included, “Yeah, honestly, it looks super interesting. Lots of great content. The visual is also super, super nice… there's everything on it, everything you can look for… just seeing from the website, it seems like really super interesting content” (P02), and “Yeah, there's, like a lot of useful information on here” (P07). Another participant shared, “I think that's why like, I'm like really excited [to participate] because I really do believe in the idea of using physical movements to actually offset low mood and anxiety” (P05). Participants expressed interest in various lessons and content, suggesting to the research that perhaps there was a little something for everyone. For example, “[Self-monitoring and habits] are very, super interesting [lessons], for sure” (P02).

Subtheme 2b: Intent to Use.

All participants reported an intent to use the platform, from signing up, to completing the lessons, and participating in PA. One participant said, “I mean, I think I definitely would agree to signing up for the 10 weeks” (P03). Participant 1 said, “Yeah, yeah, I could see [myself logging in every week and going through it]. I think… it sounds super interesting and super doable” (P01). A variety of reasons were highlighted as to why participants would be willing to engage with the intervention. For example, “I think like the timing is great. I could totally do it in 10 weeks, I think it's not too long. It's not too short. It feels like a manageable amount of time” (P06). As such, all participants had unique reasons for being interested, but all reported that they would definitely participate to some degree.

Subtheme 2c: Change Ideas.

Very few change ideas were proposed by participants with regards to improving the ease of use, or to support their intent to use. One idea proposed by a few participants was the idea of increasing interest through the sharing of more holistic health content. Participants spoke to interests in sleep and nutrition. For example, one participant commented that “sleep levels… that's like an additional component, which could have been added” (P05). Based on participant’s comments, these additions would be “nice-to-haves”, but not “need-to-haves” for demand’s sake.

Theme 3: Practicality.

Subtheme 3a: Likelihood of Success.

The current design of the intervention was reportedly practical among the population of interest, and many of the intervention components were likely to support participants. “I think having those constant pings is good. So having the emails after week one and preparing for week two… [and] making those sort of as eye catching as possible… Yeah, I mean, like, I think this [intervention] is pretty well structured” (P03). Further comments included, “I think for me it would work, I guess from my lifestyle” (P06) and, “So I think that if I were to go through the modules every week… there might be a time where I start feeling just not very confident with it. In which case, I think that I would benefit from more support, which… I think you mentioned… 30-minute one-on-ones with people. And I think that would probably be a perfect way just to have someone to confide in. And then also receive feedback in terms of how to move forward… it would be really beneficial” (P04).

Subtheme 3b: Change Ideas.

Participants were very vocal about the ways in which they might recommend improving the intervention in order to better support participants with engagement and

adherence, and a few common ideas were identified by the researcher. Some participants reported that more structure may be needed around PA, either for themselves or to benefit different participants. One youth commented, “Structure, that's what I mean. It's like the math, like, do this like 4-week program or something… there's like other apps that just have a bunch of great workouts, but you never know which ones to do” (P01). A second change idea that came up was more support for goal setting and planning earlier in the intervention. For example, “I feel like maybe the habit and the goal setting and planning would be helpful if it was at the beginning, because that's the part I at least personally, that I have troubles with. Like, I'll start and then I just like won't stick to it” (P01). Another participant expressed some uncertainty about goal setting, saying, “it looked like at the end there, we would make some goals for the week, and then stick through those. And those would be like, specific to PA like, you know, I'm going to do X minutes of this. Is that what that's supposed to look like?” (P04). Lastly, participants had many suggestions for how to integrate more social support into the intervention. Many different suggestions around this were raised, including having some point of connection among participants or having more direct support from the research coordinator. Some suggestions from participants included, “I was thinking maybe like, a forum or something where people could chat. I know that it's popular these days” (P06) and, “the only thing obviously, that would make it more like accountable is literally having somebody, like, work with you” (P03).

Theme 4: Integration.

Subtheme 4a: Perceived Sustainability.

Sustainability was a challenge for many participants to comment on, likely considering the interview was their first time seeing the intervention platform and the

exposure was quite brief. Some participants preferred not to comment. Other participants willing to comment generally spoke to the design of the program and whether or not this might contribute to participant adherence. Participant 2 said, “Yeah, well, I guess the program is built in a way so that it is already something around long-term– talking about the necessity of building things into habits etcetera. So, from that point of view, I guess someone going through this might get some good habits around PA” (P02). Another participant commented, “Yes, I believe that I can incorporate it. And hopefully after as well. I think what would really make it stick would be if it were to address those issues that I've mentioned, which is that like, just a lot of insecurity that comes with working out, that has been the biggest inhibitor for me over like the past many years… if I were to work on that through the modules, which it seems like there are certain lessons that do address that, I think that would be make it much more likely for me to maintain the program” (P04). In general, participants who commented considered the intervention most likely sustainable.

Subtheme 4b: Change Ideas.

No common change ideas were proposed by participants to increase sustainability long-term. It was inferred by the researcher that participants did not have enough experience with the intervention to develop any opinions on this.

Discussion

The purpose of this study was to share the perspectives of young people with experience of low mood and/or depression and their proposed change ideas with regards to an existing online PA intervention. This study followed the first seven steps of the IDEAS framework (Mummah et al., 2016) and framed qualitative feedback based on

Bowen and colleagues (2009) framework of areas of focus for feasibility studies. This evidence informed the tailoring of the online PA intervention for youth with low mood and/or depression intended to be trialed. For a list of changes integrated within the intervention as a result of these study findings, see Appendix D.

Participants reported high acceptability of the online PA intervention platform and procedures. This is not unexpected, considering the feasibility outcomes seen in studies like that by Hollman and colleagues (2022). Researchers employed a comparable version of the M-PAC online intervention (i.e., alpha version was the 2019 online intervention developed by Liu and colleagues) minimally adapted through targeting for new moms and reported high post-intervention acceptability. Logically, participants in this trial had a particular interest in the mental benefits lesson, and it was determined that this lesson would be frontloaded in the beta platform given repeat suggestion. Although acceptability was generally high, a number of young adults in this study made comments indicating that some of the intervention content may have been less accessible, and therefore acceptable. In particular, these comments referred to information depicted in graphs within the website. Considering again the study by Hollman and colleagues, these researchers did report some low scores on certain aspect of acceptability related to the website, however graphical content was not mentioned as being a factor in either the qualitative or quantitative evaluations. To the author's knowledge, the majority of interventions specific to the population of interest featuring a website platform and evaluating acceptability have been text-driven (Kerr et al., 2008; Mailey et al., 2010). As such, it is difficult to draw conclusions regarding the appropriateness of including such information in interventions among young people with experience of low mood and/or

depression. Given this evidence, graphs were reviewed but ultimately determined to be acceptable for trial. However, ongoing research which continues to investigate acceptability is important, particularly when it comes to aspects of accessibility for all participants. Overall, acceptability for this intervention was high, with some accessibility ideas posed for consideration in future research.

It was very encouraging to hear generally positive feedback from youth participants regarding the demand for this intervention. All participants reported a general (and sometimes eager) interest in the program, and an intent to use. This is not surprising considering the recent interruption to in-person mental health services, and lacking options for online prevention and treatment (Samji et al., 2021). Similar to acceptability feedback, participants again expressed an appetite for education around the benefits of PA for mood. Similar educational modules in related interventions have also been perceived positively by participants (Mailey et al., 2010). Some interesting change ideas were raised by participants, including requests for more holistic health education and supports. Clinical recommendations for certain dietary and sleep approaches do exist (Ravindran et al., 2016), and successful interdisciplinary intervention approaches are emerging (e.g., Clemente-Suárez, 2020). Unfortunately, such approaches can require considerable resources to coordinate, including clinicians and researchers with interdisciplinary expertise. While noteworthy for researchers in the field of interdisciplinary and alternative treatment research, these suggestions do move beyond the scope of this trial. Overall, the shared content of participant feedback focused on the demand of the intervention was encouraging, and drew researcher attention to particular

lessons which may have more salience among this population with common mood challenges.

The intervention was generally considered practical by all participants, with some constructive change ideas proposed. Participants frequently drew links between the overall structure and organization of the intervention and their likely success with engagement. This finding agrees with retention, data usage, and useability findings by Hollman and colleagues (2019). They reported high retention, adequate and consistent weekly engagement across the 10-week study, and above average usability among new moms. Participants also highlighted a number of Behaviour Change Techniques incorporated into the current intervention that supported practicality, including shaping knowledge, social support, and goal setting. Participants' comments align with research which shows that including at least three clusters of Behaviour Change Techniques may bolster intervention efficacy (McEwan et al., 2019). In addition, participants spoke to a number of additional supports that might be helpful to them when it comes to intervention engagement and adherence. These included additional structure, social support among participants, and earlier guidance around goal setting and planning. These findings align with previous qualitative research reporting that structure and peer-based social support are ideal features of community-based PA interventions among adults with depression (Sims-Gould et al., 2017). Altogether, it was determined that multiple changes be made to improve practicality through more structured programming and peer supports. Participants' feedback made clear the importance of incorporating an intentional selection of Behaviour Change Techniques and known community recommendations whenever possible into PA interventions.

Integration was generally spoken to positively, but minimal feedback was shared with regards to this factor. With the interviews having been brief, it is understandable that this might make it difficult to comment on aspects like ongoing adherence to the intervention and sustainability of PA thereafter. Some empirical evidence suggests that theory-based, PA interventions can successfully impact sustained PA levels and long-term improvements in mood among participants (e.g., Motl et al., 2005). Still, more research is needed to better understand PA intervention integration and behaviour change sustainability, as well as the benefits for those with depression (Ravindran et al., 2016). Findings in this study draw attention to the need for more research with designs geared to address gaps in knowledge around long-term outcomes of alternative mental health care and treatment.

Strengths & Limitations.

It is important to consider the strengths and limitations of this research. This study allowed for youth with experiences of low mood and/or depression to voice rich qualitative feedback related to their mental health care and treatment. Interviews were semi-structured, which allowed space for participants to voice opinions and comments of importance to them. Additionally, the sample of youth participating in this study was diverse based on ethnicity and clinical experiences. Despite the rich feedback youth shared, there are some limitations to note. There likely was some degree of selection bias among participants (Smith & Noble, 2014), which may have falsely increased the agreement within themes. This is despite the researcher's best efforts to conduct a rigorous and reflexive analysis (Tracy, 2010). Additionally, engagements with participants were short; participants only had a few minutes to review and understand the intervention before being asked to follow-up with immediate feedback. This may have

limited the depth to which they could speak to feasibility. Another limitation was the small sample size of seven participants. Knowing when to stop data collection can be a challenge, and discussion is ongoing among qualitative researchers (Braun & Clarke, 2019a). Ultimately, this study aimed to achieve a meaningful and pragmatic period of engagement with participants. Still, proponents of reflexive thematic analysis suppose that further data collection would likely have yielded additional interpretations and considerations for future PA intervention research.

Conclusion

Researchers determined that young adult interview participants who identified with experience of low mood and/or depression generally found the online alpha intervention to be acceptable, in-demand, practical, and sustainable. This was based on a continuous, mixed inductive and deductive thematic analysis (Braun & Clarke, 2019; 2020) guided by Bowen and colleagues (2009) framework of areas of focus for feasibility studies. In addition, a number of change ideas were proposed within each respective area of focus (with the exception of integration). These included suggestions like improvements to the accessibility of some intervention content, more structured PA recommendations, and additional peer support. Understandably, participants had little feedback with respect to integration, likely considering the lack of prolonged intervention engagement for the purposed of this study. Overall, change ideas raised by participants were reviewed considering a number of factors, including the prevalence across participants, the scope of the intended feasibility trial, and existing evidence. A total of six changes were made to the alpha site pertaining to the areas of practicality, demand and acceptability, and a beta version was prepared for launch into a feasibility trial.

Chapter 3 Study 2

A Feasibility Study of an Online, Physical Activity Intervention for Young Adults with Experience of Low Mood and/or Mild to Moderate Depression Engaged in Community and Primary Clinical Care

Abstract

Background: Online physical activity (PA) interventions have increased PA and improved mood among young adults with depression, but trials are only beginning to understand factors of feasibility and how best to optimize protocols to engage target participants. **Methods:** This study reports on outcomes from a randomized feasibility trial exploring the efficacy of an existing 10-week, online, PA intervention. The intervention featured 10 psychoeducational lessons based on the Multi-Process Action Control framework targeted to youth ages 19-30 with low mood and/or mild to moderate depression. Recruitment was coordinated with two community primary care clinics in Victoria, BC, plus additional social media advertising. **Results:** A total of 120 individuals expressed interest in the trial. Low recruitment (26, 21.7%; 3.8% clinical) and retention (16, 61.5%), and sufficient acceptability (7, 64.0%) were determined. Secondary outcomes showed plausible improvements for intervention over control group participants on both PA ($\eta_p^2 = 0.55$) and mood ($\eta_p^2 = 0.18$) outcomes. Directional changes in favor of the intervention compared to controls were also observed among the intervention group for regulatory and reflexive M-PAC constructs. **Conclusions**: Given these results, this trial was not recommended for RCT; rather further pilot research was recommended with possible changes including active control group(s) and multi-site recruitment approaches. Findings indicate potential intervention benefits if researchers can better recruit and retain participants.

Introduction

Of all mental illness diagnoses, some of the most disruptive are depressive disorders-- a unique classification of mood disorders. Major depressive disorder (MDD) is one such disorder that features "the presence of sad, empty, or irritable mood, accompanied by somatic and cognitive changes that significantly affect the individual's capacity to function" (p. 155). Diagnostic criteria pertaining to MDD are an array of symptoms, such as weight and sleep disturbances, that can present as either positive and/or negative symptoms. This diversity in the symptomology of MDD can make this disorder particularly complicated to diagnose and manage (Richards et al., 2004). Individuals diagnosed with MDD in the last year are known to have anywhere from two-fold to four-fold higher functional impairment compared to those without an MDD diagnosis (Bromet et al., 2011). Such impairment has broader societal level impacts in areas like the workplace, and can impact levels of employment, absenteeism, and productivity (Lerner & Mosher, 2008). Furthermore, MDD was ranked by the Global Burden of Disease Project as the second leading cause of disability adjusted life years in Canada (Patten et al., 2016). As such, major depression has been identified as a global public health priority (Bromet et al., 2011; Patten et al., 2016).

MDD has the highest prevalence of all mental illnesses with a global prevalence of 4.7% (Steel et al., 2014). In some countries, the prevalence rate for MDD is much higher than this average. For example, a recent study suggested the one-year prevalence for MDD between April 2012 and June 2013 in the United States was approximately 10.4% (Hasin et al., 2018). Furthermore, prevalence is two to three times higher among 18- to 29-year-olds in comparison to older adults 60-years and older (Hasin et al., 2018).

Most alarming, evidence is beginning to indicate that these prevalence rates may even be understated with respect to mental illness for special populations, such as racialized young adults (Hansson et al., 2012; Hop Wo et al., 2020) and men (Martin et al., 2013). Moreover, factors related to the COVID-19 pandemic have been shown to correlate with increased symptoms of depression (Rajkumar, 2020). This is especially true in young adults, under the age of 30 (Zheng et al., 2021). It has been suggested that COVID-19 has "simply accentuated pre-existing trends" (Boyce, 2020), and there is an urgent need for mental health focused research to evaluate strategies that can help to offset the many risks associated with depression.

Models of care for major depression in Canada continue to face considerable challenges, with many MDD patients struggling to receive appropriate care. While individuals may experience severe episodes of mental illness and be admitted to ambulatory or inpatient care, a significant number of Canadians will receive first-line treatment for mental health concerns through their primary care physician or family doctor. Treatment recommended by the primary care physician frequently includes Cognitive Behavioural Therapy, traditional talk therapy and/or pharmacological treatment (i.e., anti-depressant and/or anti-psychotic medication). Specialist care for these treatments from clinical counsellors, psychologists and psychiatrists can require a lengthy referral process, multiple appointments for the patient, travel to and from various clinics, as well as significant costs to the health care system. The search for innovative alternative and accessible models of care for patients has been a focus in clinical practice and research in recent years.

Physical activity (PA) is one alternative treatment for MDD with significant evidence to support its effectiveness, as well as its ability to combat common concerns with traditional care. Numerous systematic reviews and meta-analyses have consistently shown moderate to large effects of PA for improving mood (Cooney et al., 2013; Danielsson et al., 2013; Josefsson et al., 2014; Krogh et al., 2011; Nyström et al., 2015; Rosenbaum et al., 2014; Silveira et al., 2013; Stanton & Reaburn, 2014; Stubbs et al., 2016). Given this body of evidence, treatment with PA is now formally recommended in multiple countries across the globe. In Canada, the Canadian Network for Mood and Anxiety Treatments (CANMAT) has recently reviewed and synthesized the evidence, thus opting to revise treatment guidelines. They now recommend exercise as a first-line monotherapy for mild to moderate MDD and a second-line adjunctive therapy for moderate to severe MDD (Ravindran et al., 2016). Generally, 30 minutes of at least moderate intensity supervised exercise three times per week for nine weeks is what CANMAT recommends currently (Ravindran et al., 2016). Of note, these recommendations also take into account evidence to suggest that PA presents essentially no contraindications for individuals with depression (Rhodes, Temple, & Tuokko, 2011). As such, PA may offer an approachable, effective and safe alternative or parallel approach to traditional MDD care and treatment.

Despite strong, reliable evidence demonstrating the benefits of PA for depression, approximately two thirds of individuals with MDD do not meet public health recommendations for PA (Schuch et al., 2017). In fact, individuals with MDD are known to experience declines in PA levels in association with their diagnosis (Hiles et al., 2017). This is hugely concerning considering it is well-established that the general population

without MDD, and additional barriers to activity (Kramer et al., 2014), already struggle to meet Canada activity guidelines (Ross et al., 2020). Considering the many benefits of PA, such rates are very concerning, and effective interventions are drastically needed.

Interventions based on a sound theoretical frame are desired in PA promotion (Craig et al., 2008; Prestwich et al., 2015). To date, the majority of health behaviour intervention research has been based on social cognitive theories (McEwan et al., 2019). While there are many different social cognitive perspectives, all include the tenet that individuals' have particular internal processes which contribute to and can build to determine behavioural outcomes (e.g., Schunk & DiBenedetto, 2020). These approaches consider individual-, behavioural- and environmental-level factors, and continue to be applied within intervention studies with reasonable success (Beauchamp, Crawford, & Jackson, 2019; McEwan, et al., 2019). Unfortunately, there are a number of gaps in understanding that these approaches have been unable to illuminate. One major limitation is the relationship known as the "intention-behaviour gap", where intention is considered the most proximal antecedent to behaviour, and yet a significant amount of behaviour remains unexplained by "good" intentions or expectations alone. A large pool of evidence suggests that approximately half of behaviour change can be explained by intention alone (Sheeran & Webb, 2016). Such limitations have indicated room for theories which might explain additional mechanisms of behaviour change accounting for the remaining variance.

One response to the limitations of longstanding theories of behaviour change was the development of action control theories (Rhodes, 2015). These approaches seek to build on extant theories by incorporating concepts related to behaviour regulation and

maintenance. The majority of the additions within action control approaches tend to be volitional in nature. These concepts are believed to be important to the uptake and maintenance of health behaviours (Rhodes, 2017). Though theorists of action control models tend to agree on the inclusion of these additional factors related to behaviour change, the mechanisms behind them are not well understood and they vary considerably from model to model. Multi-Process Action Control (M-PAC; Rhodes, 2014) is one framework that posits additional behavioural, cognitive and emotional regulation constructs, as well as habit and identity as important factors in behaviour change processes. Rhodes posits these regulatory and reflexive factors as integral to the behaviour change process, and preliminary observational and experimental research to support this view is emerging (e.g., Rhodes et al., 2021; Hollman et al. 2022; Husband et al., 2018). There is however, still much research to be done to apply it to diverse populations and to further distinguish its potential to offer more understanding and applications for real-world interventions.

The number of studies employing action control theories among youth with depression is very limited (Kramer et al., 2014; Miller, 2017), and to the author's knowledge, M-PAC in particular has never been applied among this population. Many researchers have taken theory-based approaches with depressive youth borrowed from psychotherapy (Kerr et al., 2008; Mailey et al., 2010). Importantly, the few studies involving action control theories have begun to elucidate behavioural constructs that might be most pertinent for interventions with patients with MDD. For example, Kramer and colleagues (2014) found that, in comparison to non-depressive individuals, those diagnosed with depression can experience significant motivational and volitional deficits.

In particular, their sample of depressive patients had increased negative outcome expectations and significantly reduced action self-efficacy related to PA. The added explanatory power of emerging action control-based constructs and their relevance for this population so far suggests that M-PAC could be a beneficial model to explore in this context. Furthermore, M-PAC has been successfully applied with a number of populations known to experience similar and related health barriers (e.g., Tanna et al., 2017). Altogether, evidence indicates that pilot research that begins to explore the issue of PA engagement among youth with MDD through the lens of M-PAC framework could be beneficial.

Interventions have become a significantly more convenient and accessible option with the introduction of online programs which have demonstrated efficacy, acceptability and effectiveness for MDD patients. Effect size ranges for online programs are similar to in-person interventions (Mohr et al., 2013). Unfortunately, a paucity of research exists for online PA interventions for depression. Among the few studies that do exist however, researchers have reported some encouraging findings (Kerr et al., 2008; Kramer et al., 2014; Lambert et al., 2018; Mailey et al., 2010; Nyström et al., 2015; Strom et al., 2013). For example, Kerr and colleagues (2008) found significant changes in all of their outcome measures including steps and depressive symptoms in their PA intervention pilot study. At the present moment, digital interventions are ideal given their ease of access and ability to be carried out safely remotely. Other countries employing online PA interventions are finding success in the wake of the pandemic's detrimental physical and mental health effects (Xiong et al., 2020). Interestingly, despite the many indications for good acceptability and efficacy, online approaches still face consistent challenges with

factors of feasibility. Lambert and colleagues (2018) had a recruitment rate of 34% for their web-based PA intervention for depression. Kerr and colleagues (2008) reported a 64% retention rate for their internet- and telephone-based PA intervention. These rates are considered low when we compare to in-person alternatives. Online PA interventions might present a most timely, effective and improved form of treatment delivery for individuals seeking alternative and complementary care for MDD, but further pilot research is needed to better understand feasibility.

PA interventions for individuals with mental illness have tended to focus on convenience samples within inpatient units and ambulatory care (Minaeva et al., 2020; Stanton et al., 2018), and gaps in community programming are considerable. Community or primary care accounts for a significant amount of the first-line treatment for mental health disorders in Canada, and the paucity of alternative treatment research in outpatient settings is quite shocking. Qualitative research participants with mental illness have themselves suggested that behavioural approaches need to be integrated into community clinical care (Hodgson et al., 2011; Lederman et al., 2017). Additional studies continue to validate this concern (Burton et al., 2012; 2020). This recommendation is also supported by research which shows that exercise prescription initiatives continue to be severely lacking in mental health care (Lederman et al., 2017; Stanton et al., 2018). This is especially true for programs that are considered to be pragmatic and sustainable (Lederman et al., 2017). Community mental health practitioners are ideally positioned to offer trusted referral to parallel healthcare professionals, like Kinesiologists, and this has been shown to improve patient participation in activity programs (Pearsall et al., 2014).

Embedded PA prescription by professionals and intervention programs in clinical care systems are identified needs.

It is important to ensure that information available regarding optimal intervention approaches and population needs are rigorously integrated as part of the development of ongoing research, and Integrate, DEsign, Assess, Share (IDEAS) framework (Mummah et al., 2016) has been applied as a guide for this trial. Study 1 explored stages one and two of this framework: "Integrate and DEsign" (p. 3), among end-users of the intervention. Seven youth with low mood and/or depression participated in individual, semi-structured interviews with questions framed around Bowen and colleagues (2009) "key areas of focus for feasibility studies" (p. 454). Based on a thematic analysis of interview data, it was determined that the existing alpha-intervention (Liu et al., 2019) had good acceptability, demand and practicality. In addition, a total of six change ideas spread across these themes were raised. Ultimately, five changes were integrated with a beta-version of the online intervention for trial (see Appendix D). Based on IDEAS (Mummah et al., 2016), this study proceeds with the third stage, focusing in on "Assessment" (p. 3), which includes phases of piloting and evaluation.

Aim and Contributions.

The primary aim of this study is to assess the feasibility of a 10-week, online, action control theory-based PA intervention targeted for participants with experience of low mood and/or mild to moderate MDD (i.e., subthreshold or clinical level depression). This research also explores mental health, PA and behaviour change outcomes being considered for a future effectiveness randomized controlled trial (RCT).

Research Questions and Progression Criteria.

Primary Outcomes.

i) What are the recruitment and retention rates of the study given the number of participants identified, eligible, consented, randomized, fully completed and followed-up 10 weeks after baseline?

C1: *If the recruitment rate is 65-100% (Firth et al., 2016; Jackson & Waters, 2005; Lederman et al., 2020; Sylvia et al., 2013) and the retention rate is 70-100% (Firth et al., 2016; Lederman et al., 2020; Lee et al., 2014; Pelletier et al., 2005; Sylvia et al., 2013) then these measures will contribute to successful recommendation for a future RCT.*

ii) How acceptable are the intervention procedures according to participant experience measures?

C2: *If 50% or greater of participants in the intervention group report mean acceptability ratings on the adapted Satisfaction Survey of ≥ 3.5, then this measure will contribute to successful recommendation for a future RCT.*

Secondary Outcomes.

iii) What will be the most appropriate outcome measures for a future RCT?

C3: *If percent change trends in the positive and negative direction for both PA and depression severity respectively, and additionally, minimal clinically important differences (Lowe et al., 2004; McMillan, Gilbody, & Richards, 2010) are met or exceeded for the majority of intervention group participants, then both PA and depression could be considered appropriate primary outcomes for a future RCT.*

Tertiary Outcomes.

iv) Is Multi-Process Action Control model efficacious at explaining changes in PA behaviour with MDD diagnosis as a moderator?

C4: *If there are improvements in the majority of intervention group participants' levels of reflective and regulatory constructs, and PA intentions in association with increased levels of PA, then M-PAC could be considered an efficacious framework to develop future intervention trial protocols.*

Methods

Ethics.

An ethics proposal was approved by the University of Victoria Human Research Ethics Committee (#21-0301).

Registration.

This trial was registered with the National Institutes of Health registry at ClinicalTrials.gov (NCT ID#05386745).

Design.

The proposed study was formulated in consideration of the ORBIT Model for Behavioural Treatment Development (Czajkowski et al., 2015), based on the state of current evidence in the field. It was designed as a phase II preliminary testing feasibility study featuring a controlled baseline, post-intervention evaluative design with an embedded quantitative process evaluation. The control group was a waitlist condition, where participants received access to the intervention beta-platform at 10-weeks after the completion of their final assessment. This design was chosen with the aim to provide a quality, objective and continuous assessment of the acceptability throughout the intervention trial. Additionally, the controlled baseline, post-intervention evaluative design allowed for both between and within groups analyses for change across the secondary and tertiary outcomes. Importantly, this design also features a true control comparator group while being ethically responsible to provide the behavioural and

experimental treatment for all participants. In keeping with COVID-19 safety precautions, all screening, baseline, check-in and post-intervention meetings and measurement were conducted by phone or video, and research shows this does not impact the validity or reliability or any of the chosen instruments.

Participants.

Eligible participants were: (1) young adults 19-30 years of age, (2) living in British Columbia, (3) who self-identified with experience of depression (ranging from low mood and/or depressive symptoms to a formal mild to moderate Major Depressive Disorder diagnosis according to the DSM-V), (4) reported no manic episode(s) or psychosis in the past 6 months, (5) fell below the minimum Canadian public health recommendations for PA (Ross et al., 2020) for at least six months prior to screening, (6) had access to a device with internet access, AND (7) were English speaking. No exclusion criteria for sex, gender, medications, race or religion were applied. There were no contraindications to PA after screening with the Physical Activity Readiness Questionnaire (PAR-Q).

Ineligible participants were those reporting or exhibiting: (1) severe depression identified via clinical diagnosis, self-report, or as measured during screening (represented by a severity score of 20 or greater on the PHQ-9), (2) imminent risk of suicidal self-injury or behaviour at any point during the study, AND (3) history of alcohol or substance abuse in the past 6 months.

Procedures.

Recruitment took place over an approximately five-month period from February 22, 2022 through July 30, 2022. Recruitment was facilitated by Foundry Victoria Youth Mental Health Clinic and the GROW Program at Island Community Mental Health. The

main avenue planned for recruitment was direct referral by General Practitioners, Psychologists, Psychiatrists, Occupational Therapists, and other allied health professionals. Recruitment was also conducted via pamphlets available within the clinics and advertisements on clinic web platforms including websites, Facebook and Instagram pages at a rate of approximately 1 post per month. Additional recruitment via Behavioural Medicine Lab social media platforms at a rate of 1-3 posts per week (including LinkedIn, Instagram, and Facebook) was also conducted.

Potential participants in contact with the research coordinator by email were scheduled for a screening appointment either by phone or online video chat. Potential participants were provided with the Consent Form, Baseline Questionnaire (see Appendix B), and Par-Q+ in a reminder email a minimum of 24 hours prior to the screening for their review. At the initial screening, potential participants were briefed regarding the expectations and commitment and consent procedures associated with the study, as well as screened for appropriate mood and PA levels in accordance with study inclusion criteria. Youth deemed ineligible during the screening were informed immediately, and other community resources for mental and physical health support provided. For those eligible, up to one week was allotted for additional consideration of the provided information and the return of the required, completed and signed documents. Potential participants who did not respond within one week were followed up with by telephone or email. Those eligible participants who ultimately completed the screening, baseline assessment and consent process were next enrolled and randomized to a study condition. Participants were randomized via block randomization in the order that they enrolled. Block randomization used mixed block sizes (e.g., two, four, or six; Kim & Shin, 2014).

Depending on their assigned group, participants were either (1) given login information and access to the online platform (intervention group), or (2) instructed to continue their usual activities and await follow-up information from the coordinator in 10-weeks time (control group).

Participants were re-assessed at 10 weeks using the Final Questionnaire (see Appendix C). Only intervention group participants completed the Experience Survey portion. Following this final assessment, participants in the control group were provided all the same information that intervention group participants received at baseline with respect to the online intervention and PA recommendations, and access to all the same supports throughout their 10-week progression through the online intervention. No additional data was collected from control group participants after their 10-week assessment in order to maintain equity in the expectations across both study groups. All participants were compensated for the time taken to complete baseline and exit questionnaires in the form of a $10 coffee shop gift card sent automatically and virtually to them immediately following their final assessment appointment.

Given the nature of this two-arm parallel feasibility trial and the resources available, the research coordinator was not blinded to the participants' assignment to either the intervention or control groups (only to the block allocation). All clinical and administrative staff at partnering community clinics were blind to client participation in the study, unless clients chose to disclose this information themselves.

Safety protocols were implemented as part of this study given the possibility for adverse events to occur, such as increased suicidal behaviour. These protocols were to apply in the event that any participant(s) made a disclosure that indicated any possible

imminent risk to themselves or others at any point during the study. The coordinator was prepared for emotional and/or crisis support chats with the participant(s), and to take appropriate action to safety plan or call intervention services.

Sample Size.

An acceptable enrollment range was considered between 34 and 45. As such, the two arms of this study would ideally range from 17 to 23 participants. This recommendation was primarily based on two relevant theory-based, PA intervention feasibility and pilot studies (Kerr et al., 2008; Mailey et al., 2010). Bacchetti and colleagues (2010) argue that blanket assumptions based on power detract from innovative pilot research in many ways, and so broad estimates of power were avoided. Instead, ethical and practical considerations related to the population of interest, and an evaluation of analogous studies on a number of factors were considered. These considerations and the ultimate justification for this sample size focused on endpoints of feasibility and acceptability (Moore et al., 2011).

Intervention.

Participants in the intervention condition were invited to a 10-week, asynchronous, web-based beta-platform. The beta-platform featured 10 weekly psychoeducational lessons with a variety of interactive content. Content was deemed acceptable, in-demand, accessible, and interesting by a group of community stakeholders prior to the commencement of the study (see Study 1). The intervention was completed at participants' leisure with weekly social support email communication to guide them along (see Appendix H). Email invitations for check-ins were sent at two and five weeks, but it was communicated that these were flexible and could be scheduled at any time throughout the intervention based on participant need or interest, and participant and

coordinator availability. These check-ins were included with the aim to provide a number of potential functions including: answering participants' questions, supporting participants' navigation of the beta-platform, reviewing online content together, providing 1:1 exercise coaching, providing additional social support, and/or supporting monitoring progress.

Table 1

Outline of Online 10-Week PA Intervention Lessons and the Corresponding M-PAC Construct and Behaviour Change Technique(s)

	Lesson Name	Corresponding M-PAC Construct	Featured Behaviour Change Technique(s)
Lesson 1	"Mental Benefits of Physical Activity"	Outcome Expectations	Emailed social support weekly (lessons 1-10); Natural consequences
Lesson 2	"Physical Benefits of Activity"	Outcome Expectations	Check-in social support, Feedback and monitoring; Natural consequences
Lesson 3	"Increasing Self-Confidence for Physical Activities"	Perceived Capability	Self-belief
Lesson 4	"Learning About Your Emotion"	Affective Attitudes	Regulation
Lesson 5	"Building Social Support"	Affective Attitudes	Check-in social support, Feedback and monitoring
Lesson 6	"Building Physical Activity Opportunity"	Perceived Opportunity	Associations
Lesson 7	"Goal Setting and Planning"	Action Planning (Action Control)	Goals and planning
Lesson 8	"Self-Monitoring"	Monitoring and Coping Planning (Action Control)	Feedback and monitoring
Lesson 9	"Habit"	Habit	Repetition and substitution
Lesson 10	"Identity"	Identity	Identity

Measures

Primary Outcomes.

Acceptability.

The acceptability of the feasibility study was assessed through an adapted experience survey (see Appendix A) measure featuring a 5-point Likert scale for all items. This measure asked a variety of questions aimed at gathering participants' experience with intervention factors including appropriateness and relevance of the online beta-platform content, level of online social support via the research coordinator, and more. The measure (adapted from Husband et al., 2019) tracks to prior PA research investigating online interventions for other novel populations (e.g., new moms; Hollman et al., 2022). This outcome was measured as part of the post-intervention final assessment.

Fidelity.

Completion of the week two and midway video or telephone check-ins, though these were optional, were tracked for intervention participants. The online intervention portal automatically collected metrics of website usage (e.g., page views, time spent per page).

Secondary Outcomes.

Physical Activity.

PA was measured with the 3-item Godin Leisure Time Exercise Questionnaire (GLTEQ). GLTEQ in general has been validated within numerous experimental conditions, including among young adult samples (Godin, 1985). It has been successfully employed in PA interventions with samples with depression (Chu et al., 2009; Combs et al., 2014). Furthermore, it allows for the comparison of different activity intensities

which will be relevant to this study. Given the interest in MVPA primarily, the open duration format of the GLTEQ was used. This response scale has been applied in related research to assess PA change (e.g., Hollman et al., 2022) and has been recommended based on research taking into consideration the range of available PA scales (Courneya et al., 2003). Participants self-administered the questionnaire with some support from the research coordinator at the baseline and final assessments. Activity level was calculated by multiplying frequency and duration in each of the moderate and vigorous categories, and then determining a sum total of average weekly MVPA minutes.

Depression.

Depression severity was measured using the Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 is one of the most validated assessment tools for depression available. It has been validated in all settings relevant for this study including primary care (Arroll et al., 2010), within populations with psychiatric illness (Beard et al., 2016), and in modified assessment procedures (Fine et al., 2013). Importantly, the PHQ-9 has also been shown to be sensitive to change in depression symptomology over time (Beard et al., 2016; Lowe et al., 2004). Additionally, originally validated Minimal Clinically Important Differences (MCIDs) for the PHQ-9 have been investigated (Lowe et al., 2004; McMillan, Gilbody, & Richards, 2010), and established methods for determining this metric have proven quite reliable in community samples. Participants self-administered the questionnaire at the baseline and final assessments with some support from the research coordinator. Internal consistency was acceptable for all baseline and follow-up measurements (see Appendix E).

Tertiary Outcomes.

Multi-Process Action Control Framework Constructs.

Reflective constructs of pre-intentional perceived capability (Bauman et al., 2012; Rhodes et al., 2017), perceived opportunity (Ajzen, 2002; Rhodes, 2014; Rhodes & Courneya, 2003; 2004), and affective and instrumental outcome expectations (McEachan et al., 2016) were assessed. An evaluation of both the intensity and decisional nature of intentions towards MVPA were included in the behaviour questionnaire (Fishbein & Ajzen, 2005; Rhodes & Rebar, 2017; Schwarzer et al., 2011; Zhang et al., 2019). Integral regulatory constructs including emotional and behavioural regulation (action control) (Bauman et al., 2012; Carraro & Gaudreau, 2013; Rhodes et al., 2017; Rhodes & Dickau, 2013; Sniehotta et al., 2005), and reflexive habit (Rebar et al., 2016; Rhodes, 2017; Rhodes & De Bruijn, 2013) and identity (Rhodes, Kaushal, & Quinlan, 2016) were also measured. A complete list of constructs evaluated in this study and references relevant to the adaption of proposed instruments can be found in Appendix E. Each of the behavioural construct measures and items employed in this study were selected for their measurement properties. In particular, reports of construct validity and reliability, as well as internal consistency were major considerations. Internal consistency for these measures was good and can be seen in Appendix I.

Data Analysis.

Recruitment rate was calculated by the number of individuals recruited, consented and ultimately enrolled, divided by the total number of individuals eligible and approached and/or referred to participate in the program. Recruitment site was also collected whenever possible in order to evaluate the level of community care integration. Progression criteria were based on studies with similar feasibility designs and those sampling from young adult populations with mental illness. As a result, a successful recruitment rate would be considered 65+%.

Retention rate was calculated by taking the number of individuals enrolled in the study who completed to the 10-week endpoint and dividing by the number of individuals enrolled in the study (including drop-outs). With respect to progression criteria, 80+% is considered a strong trial when sampling among the general population (Jackson & Waters, 2005). That said, trials involving participants with mental illness are at high-risk of dropouts due to significant adverse mental health events (Firth et al., 2016; Lederman et al., 2020; Sylvia et al., 2013). Retention rates in PA intervention feasibility studies with adults with clinical mental illness diagnoses (Lee et al., 2014; Pelletier et al., 2005; Ramji et al., 2021), and those more specifically with young adults with clinical mental illness diagnoses (Firth et al., 2016; Lederman et al., 2020; Lee et al., 2014; Pelletier et al., 2005; Sylvia et al., 2013) range from 64-82%. This considered, a more flexible retention criteria of 70+% was considered feasible for the purposes of this trial.

In order to assess acceptability, calculations of mean and standard deviations were conducted for the satisfaction measure. Scores of 1 (i.e., Strongly Disagree) and 2 (i.e., Somewhat Disagree) indicate levels of dissatisfaction, 3 (i.e., Neither Agree Nor Disagree) indicates neutrality, and 4 (i.e., Somewhat Agree) and 5 (i.e., Strongly Agree) indicate some sort of satisfaction. As such, and based on acceptability reported in a prior, related trial (Lambert et al., 2019) a mean score of ≥ 3.5 for greater than 50% of the intervention participants was deemed acceptable for recommendation for a full RCT.

Altogether, if the trial has ratings of recruitment, retention, and acceptability surpass a priori established benchmarks then a full-scale RCT would be recommended.

Outcome measures (including secondary: PA and depression symptom severity, and tertiary: M-PAC framework variables) were analysed using SPSS Version 28.01.1

for Windows. Descriptive statistics were calculated for all primary measures and to give context to the nature of the intervention and control groups. Multiple one-way, between group analysis of covariance (ANCOVA) tests controlling for baseline were used as the method of analysis for the secondary and tertiary outcomes (Porter & Raudenbush, 1987). Descriptive statistics, *F*-values, and effect sizes (small, medium or large; Lakens, 2013), as well as percent change and established MCIDs (Lowe et al., 2004; McMillan, Gilbody, & Richards, 2010) for depressive populations are reported to evaluate intervention fidelity and efficacy plausibility.

Results

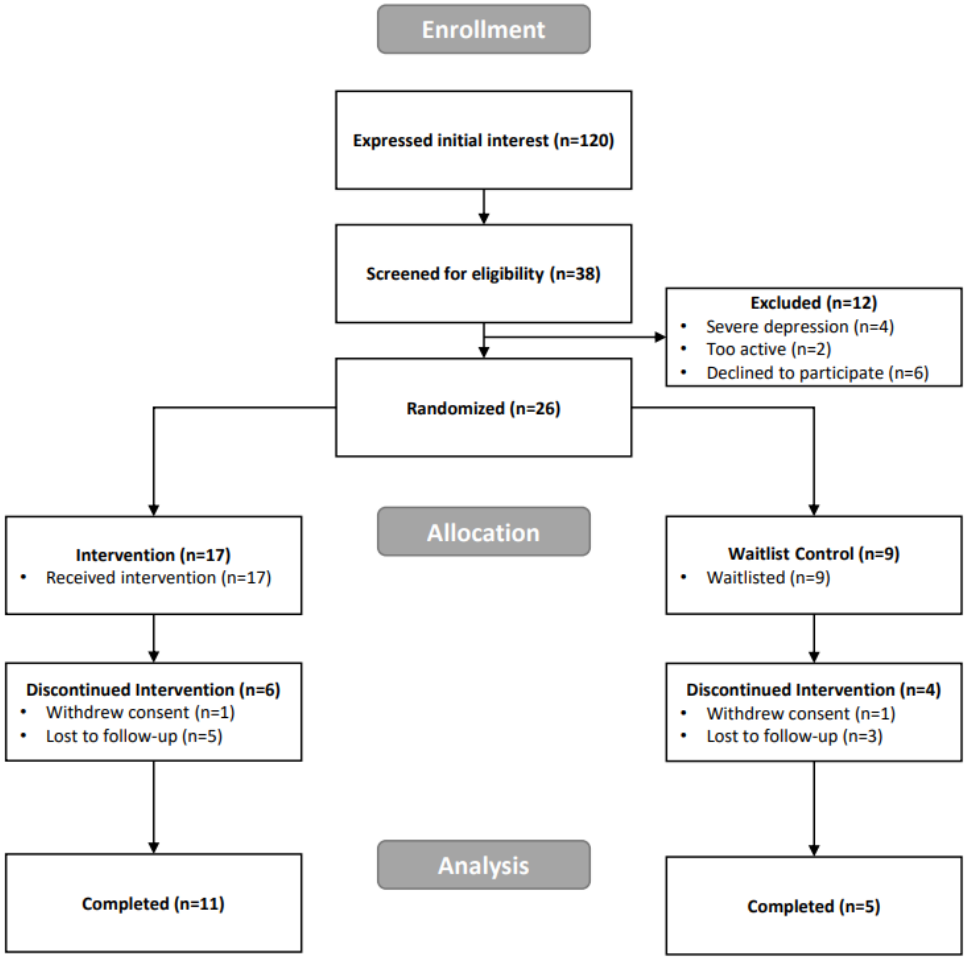
Feasibility.

Recruitment.

A total of 120 individuals expressed interest in taking part in the study between February 26, 2022 to July 30, 2022. A CONSORT Flow Diagram can be seen in Figure 1 (Eldridge et al., 2016). A subset of 33 individuals reached out to express their interest to the coordinator while fully aware that they were too old to participate. Of this subset, those who were willing to share their age were evenly spanned between 30 and 70 years. A total of 38 individuals were screened for eligibility; twelve individuals were excluded (four due to the severity of their depression score, another two given they were too active, and six elected not to participate citing worsening mental health or competing commitments having arisen). Ultimately, 26 participants were recruited to participate; 17 participants were randomly allocated to the intervention group, and 9 to the waitlist control group.

Figure 1

CONSORT Flow Diagram



Monthly recruitment rates from March 1 through July 30 respectively were 5/15 (33.3%), 14/58 (24.1%), 3/21 (14.3%), 0/17 (0%) and 4/9 (44.4%). The average recruitment rate over four months was 26/120 (21.7%). Though multiple recruitment avenues in-person, in-clinic, and online were used throughout this period, 25 out of 26 participants (96.2%) reported hearing about the study through social media advertisements. Only one participant reported coming to the study by way of information shared by a primary care provider.

Sample.

A total of 26 participants were recruited for this study; 17 intervention group and 9 waitlist control group participants. Baseline characteristics of the recruited participants are presented in Table 2.

Table 2

Demographic Characteristics of Study 2 Participants Providing Consent and Baseline Assessment

	Overall (N = 26)	Control (*n* = 9)	Intervention (*n* =17)
Age	25.19±3.45	26.22±3.49	24.65±3.41
Gender			
Male	5 (19.2%)	0	5 (29.4%)
Female	19 (73.1%)	8 (88.9%)	11 (67.4%)
Transgender	1 (3.8%)	1 (11.1%)	0
Gender nonconforming	1 (3.8%)	0	1 (5.9%)
Ethnicity[a]			
Aboriginal	1 (3.8%)	0	1 (5.9%)
Caucasian	16 (61.5%)	6 (66.7%)	10 (58.8%)
Fijian	1 (3.8%)	1 (11.1%)	0
Chinese	2 (7.7%)	0	2 (11.8%)
African American	1 (3.8%)	0	1 (5.9%)
Turkish	1 (3.8%)	0	1 (5.9%)
Latin American	1 (3.8%)	1 (11.1%)	0
East Asian	1 (3.8%)	0	1 (5.9%)
South Asian	2 (3.8%)	1 (12.5%)	1 (5.9%)
Middle Eastern	1 (3.8%)	0	1 (5.9%)
West Asian	1 (3.8%)	0	1 (5.9%)
Iranian	1 (3.8%)	0	1 (5.9%)
Did not disclose	2 (7.7%)	0	2 (11.8%)
Education			
8th grade	1 (3.8%)	0	1 (5.9%)
High school diploma	7 (26.9%)	3 (33.3%)	4 (23.5%)
Vocational school or some college	1 (3.8%)	0	1 (5.9%)
College or university diploma/degree	10 (38.5%)	2 (22.2%)	8 (47.1%)
Professional or graduate degree	7 (26.9%)	4 (44.4%)	3 (17.6%)
Employment			
Employed (any FTE)	18 (69.2%)	7 (77.8%)	11 (64.7%)
Student	5 (19.2%)	1 (11.1%)	3 (17.6%)

Temporarily unemployed	2 (7.7%)	1 (11.1%)	2 (11.8%)
Did not disclose	1 (3.8%)	1 (7.7%)	(5.9%)
Household Income			
< $35,000	10 (38.5%)	2 (22.2%)	8 (47.1%)
$35,001- $50,000	5 (19.2%)	2 (22.2%)	3 (17.6%)
$50,001- $75,000	2 (7.7%)	2 (22.2%)	0
$75,001- $100,000	2 (7.7%)	0	2 (11.8%)
$100,001- $150,000	2 (7.7%)	1 (11.1%)	1 (5.9%)
$150,000- $200,000	1 (3.8%)	0	1 (5.9%)
< $200,000	2 (7.7%)	1 (11.1%)	1 (5.9%)
Did not disclose	2 (7.7%)	1 (11.1%)	1 (5.9%)
Children Living at Home			
Yes	2 (7.7%)	0	2 (11.8%)
No	24 (92.3%)	9 (100%)	15 (88.2%)
Family History of Heart Disease			
Yes	5 (19.2%)	2 (22.2%)	3 (17.6%)
No	20 (76.9%)	7 (77.8%)	13 (76.5%)
Did not disclose	1 (3.8%)	0	1 (5.9%)
Smoking			
Yes	2 (7.7%)	0	1 (5.9%)
No	24 (92.3%)	9 (100%)	16 (94.1%)
Clinical Depressive Disorder			
MDD	5 (19.2%)	2 (22.2%)	3 (17.6%)
Depression - Other	3 (11.5%)	3 (33.3%)	0
No	13 (50.0%)	2 (22.2%)	11 (64.7%)
Did not disclose	5 (19.2%)	2 (22.2%)	2 (11.8%)
Co-Occurring Mental Health Condition			
Yes	4 (15.4%)	3 (33.3%)	1 (5.9%)
No	17 (65.4%)	5 (55.6%)	12 (70.6%)
Did not disclose	5 (19.2%)	1 (16.7%)	3 (17.6%)
Mood Medication			
Yes	3 (11.5%)	2 (22.2%)	1 (5.9%)
No	22 (84.6%)	7 (77.8%)	15 (88.2%)
Other	1 (3.8%)	0	1 (5.9%)
Functional Health Rating			
Poor	3 (11.5%)	2 (22.2%)	1 (5.9%)
Fair	13 (50.0%)	4 (44.4%)	9 (52.9%)
Good	5 (19.2%)	1 (11.1%)	4 (23.5%)
Very Good	5 (19.2%)	2 (22.2%)	3 (17.6%)
Excellent	0	0	0

[a]With respect to the demographic category of ethnicity, while only 26 participants responded (n = 26), instructions read that participants could select one or more ethnicities they identified with; in effect duplicating some participant counts in this category.

It is worth noting that more than three times the number of females to males participated in this study. No participants identifying as male were randomized to the control group, while five males were randomized to the intervention group. Also, approximately two times the proportion of total participants identifying as having received a clinical depression diagnosis were allocated to the control group. 33.3% of the control group also reported a co-occurring mental illness, whereas only 5.9% of the intervention group did. All other demographic data was comparable between groups, and the sample was diverse with respect to both gender and ethnic identities.

Retention.

A total of 10 of the 26 trial participants dropped out at some point throughout the study period. Eight participants did not respond to follow-up when it came time to complete the final questionnaire following intervention completion, and another two withdrew their consent (stating time constraints). A protocol of three weekly follow-ups post-intervention before communication was discontinued was followed. Overall, the retention rate was 16/26 (61.5%).

Fidelity.

Four out of 11 (36.4%) of intervention participants took part in one check-in, and none completed more than one. All check-ins were completed at the planned intervals—either two or five weeks. Three of the four check-ins completed were at the two-week mark.

Usage of the online platform varied considerably among the 11 intervention participants included in the per protocol analysis. Average total hours spent on the psychoeducational intervention lesson pages among this subset of participants was 3.4 (SD = 5.4). It was recommended that participants spend 20-30 minutes per week on the platform, thus this average time spent was seen to be sufficient on average among all intervention completers. Upon further analysis however, it was determined that six of the eleven participants who contributed to the usage data could be classified as "insufficient users"; defined for the purposes of this study as those spending no time in the psychoeducational lesson portion of the platform. Among those who do not fall into the insufficient users category, their total time spent on the psychoeducational intervention lesson pages was higher at a total of 7.3 hours (SD = 5.9). They viewed 33.2 pages (SD = 21.8) of the intervention total out of a possible 58 (57.2%). These users reported high engagement in the first half of the intervention, with the sufficient users on average viewing 66.7% of the utilized lesson content in the first five weeks.

Acceptability.

A total of 11 intervention participants completed the final questionnaire and they were included in this per protocol analysis. Importantly, given the fidelity outcomes, including exploratory usage findings, it was determined that sub-scales related to lesson and check-in acceptability should only be rated by those who were known to have participated in these aspects of the intervention. All responses were evaluated based on the a priori established progression criteria range of 3.5-5. Anything below this range was considered less than satisfactory for the purposes of this evaluation. A complete table of overall measure and item scores can be seen in Table 3. Intervention participants on

average rated their overall study experience as satisfactory (*M* = 3.73, *SD*= 0.49). Those participants who sufficiently viewed the lessons (*M* = 3.73, *SD*= 1.04), and participated in check-ins (*M* = 3.67, *SD*= 0.58) reported these intervention aspects as acceptable. This indicated that on the measure of acceptability, trial outcomes did meet recommended levels of satisfaction.

Table 3

Fully Completed Study 2 Intervention Group Participants' Ratings of Acceptability by Measure and Item

Measure	Item	*M (SD)*	*n* scoring > 3.5
Overall Lesson Satisfaction (*n*=5)		3.73[a] (1.04)	4 (80.0%)
	I was interested in completing the lessons most of the time	3.80[a] (1.10)	
	I found the lessons relevant and appropriate for my needs and goals	3.80[a] (1.30)	
	I used the tools and strategies provided in the lessons	3.60[a] (0.89)	
Overall Check-in Satisfaction (*n*=3)		3.67[a] (0.58)	2 (66.7%)
	The check-in helped to maintain my investment in the online platform	4.00[a] (0.00)	
	The check-in helped to increase my physical activity	3.67[a] (0.58)	
	There was sufficient time to discuss and review my experience with the research coordinator	3.33 (1.16)	

Overall Study Satisfaction (*n*=11)		3.73[a] (0.49)	7 (64.0%)
	My needs were met by the intervention overall	3.36 (0.93)	
	I would recommend the online platform to other people	3.73[a] (0.79)	
	I enjoyed being a part of the research study	4.09[a] (0.70)	

[a]Items that met or exceeded the cut point at which acceptability was considered in favor of the intervention and study feasibility.

Qualitative Feedback.

Feedback shared by intervention group participants was quite disparate; of the 11 intervention group participants who completed the final survey, three chose to share no additional comments, five participants' comments were quite brief and limited in detail, while three participants shared more fulsome description of their experience and feedback. Through a mix of deductive and inductive reflexive thematic analysis (Braun & Clarke, 2006, 2019b), it was determined that the data could be synthesized using themes of intervention acceptability, benefits of research participation and barriers to PA.

Intervention Acceptability

Comments specific to acceptability were few, and often not validated by similar comments from other participants. That said, the range of feedback raised with respect to acceptability included: a need for more tailoring and a request for more video content. One participant stated that they did not use the website, and "opted for other resources" (P06), but did not elaborate on why. Those participants who reported good acceptability of the intervention commented on the lessons and tools provided, as well as the overall structure and layout. For example, one participant wrote, "the program has definitely

helped me to understand why I struggled to exercise in the past. It has helped me to get better at committing to exercise. I do still have some challenges with motivating myself at times, but when that happens, I understand why, and have tools to help me deal with it" (P19). Altogether, participants provided a disparate mix of positive and constructive feedback related to the intervention.

Benefits of Research Participation

Survey respondents relayed various benefits to having participated in this trial. Three participants shared the benefit of having the opportunity to check-in with the research coordinator. Two participants even linked the intervention to efficacy; one saying "I do appreciate the check ins and the information provided on the check ins it was helpful so thank you very much. [A]nd it did help me at least go for one run" (P26). Multiple participants briefly shared about their enjoyment participating. One participant relayed how they had found "the study overall was useful" (P06).

Barriers to PA

While the theme of barriers to PA was determined, this was based on disparate comments from participants—as such it is hard to distinguish what the prominent challenges might have been for this group of intervention participants. Some challenges posed included weather, lack of support, feeling isolated, local community safety concerns, confidence and financial barriers. For example, one participant shared that they "don't feel safe running as a female alone in my city even in the daytime" (P26). That said, no two participants touched on the same barriers to PA. It was clear from participant feedback that many barriers impeded participation in PA throughout the course of the

study, but prolonged engagement with participants would have been required to elucidate these further.

Adverse Events.

There were no adverse events reported over the course of this study.

Secondary Outcomes.

Two one-way between-groups ANCOVAs were conducted controlling for baseline. Preliminary checks were conducted and the secondary data set met all assumptions of linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariates for ANCOVA. Only PA did not meet the assumption of normality. Final scores on PA were transformed by applying a log base 10 transformation, and the resulting distribution approached normal. ANCOVAs were then conducted as planned. For any cases with missing data, values were excluded variable by variable. After adjusting for baseline scores, results indicated directional, and sizeable differences between the intervention and the control group on post-intervention amount of MVPA ($\eta_p^2 = 0.55$) and depression scores ($\eta_p^2 = 0.18$). Both of these effects can be interpreted as large (Lakens, 2013). This study was not powered for significance testing, and *p* values are not reported. Results can be seen in Table 4.

Table 4

Summary of Secondary Outcomes from One-Way, Between-Groups Analysis of Covariance Controlling for Scores at Baseline

	Intervention (n = 11)	Control (n = 4)		
Outcome	*M (SD)*	*M (SD)*	F	η_p^2
MVPA	143.18 (128.13)	32.50 (23.98)	14.68*	0.55
Depression Score	5.45 (2.81)	6.13 (2.67)	2.70	0.18

Note. All table statistics calculated using per protocol analysis. Effect sizes were small ($\eta_p^2 = 0.01$), medium ($\eta_p^2 = 0.06$), and large ($\eta_p^2 = 0.14$) (Lakens, 2013).

*$p < 0.05$

Some additional planned comparisons of the secondary outcomes were conducted to determine any indication of within group differences. These additional planned comparisons included calculations of percent change and MCIDs across all participants, and all groups. Cases were excluded variable by variable as necessary. Upon analysis of the MVPA data, 55.0% (6/11) participants in the intervention group and included in the per protocol analysis achieved Canada guidelines for PA of 150 minutes of MVPA per week. None of the control group participants (0/5) achieved guidelines. All of the control group participants' MVPA trended downwards (with the exception of one whose amount of MVPA remained the same at baseline and follow-up), while 72.7% (8/11) of intervention group participants trended upwards.

With respect to depression-related outcomes, 90.9% (10/11) intervention group participants improved their depression score to some degree from baseline to final assessment, while 50% (2/4) of control group participants reporting baseline and final data improved to some degree. Of those showing improvement among the intervention group, a subset of six of these participants (72.7%; 8/11) also met general standards for MCID (follow-up score of 10 ≥ and 50% or greater improvement in score; McMillan et al., 2010). A further subset of five of these intervention participants (45.5%; 5/11) met more recently proposed and stringent MCID standards (follow-up score 13 ≥ and 50% or greater improvement in score). A subset of 72.7% (8/11) intervention group participants showed decreased depression scores sufficient enough to cross into a sub-clinical

threshold. This is in comparison to the control group where only one of the four participants (25%; 1/4) reported a reduction in depression symptoms that dropped them into a subclinical category. No other MCIDs were determined among the control group participants.

Tertiary Outcomes.

Multiple one-way, between-groups ANCOVAs controlling for baseline were conducted for each of the behavioural variables. Preliminary checks were conducted and the secondary data set met all assumptions of reliability of the covariates, linearity, homogeneity of regression slopes, and reliable measurement of the covariates for ANCOVA. Final scores for instrumental attitude did not meet the assumption of normality (i.e., large negative skew). Final scores for implementation intentions and habit did not meet the assumption of homogeneity of variance. Instrumental attitude and implementation intentions scores were transformed by reflecting and taking the log base 10. Each of the distributions of scores for instrumental attitudes and implementation intentions approached normal after transformation, and further analysis with ANCOVA was conducted as planned. For any cases with missing data, values were excluded variable by variable. Dependent habit scores could not be effectively transformed to equalize variances; thus, this construct was excluded from the statistical analysis and only percent improvement was reported. Results are reported in Table 5, and reliabilities for these measures in Appendix I. This study was not powered for significance testing, and *p*-values are not reported.

Table 5

Summary of Changes on M-PAC Framework Behavioural Variables by Group

Outcome	Baseline *M* *(SD)*	Follow-up *M (SD)*	*n* improved (%)	*F*	η_p^2
Affective Attitude				0.60	0.04
Control	4.80 (0.58)	4.68 (0.52)	2 (40.0%)		
Intervention	4.67 (1.04)	4.18 (1.48)	6 (54.5%)		
Instrumental Attitude				0.05	0.00
Control	6.90 (0.22)	6.80 (0.45)	0		
Intervention	6.50 (0.55)	5.55 (1.75)	1 (9.09%)		
Perceived Capability				1.34	0.09
Control	4.75 (5.90)	5.80 (0.54)	1 (20.0%)		
Intervention	5.80 (0.73)	5.09 (1.22)	2 (18.2%)		
Perceived Opportunity				0.80	0.06
Control	6.47 (0.61)	6.53 (0.51)	1 (20.0%)		
Intervention	6.03 (0.43)	5.79 (0.86)	2 (18.2%)		
Implementation Intentions[a]				2.00	0.13
Control	6.40 (0.65)	6.20 (0.45)	2 (40.0%)		
Intervention	5.91 (1.07)	4.73 (1.56)	7 (63.6%)		
Behaviour Regulation				11.16*	0.46
Control	1.88 (0.86)	1.47 (0.54)	0		
Intervention	1.74 (0.59)	2.98 (0.99)	9 (81.8%)		
Emotion Regulation				9.47*	0.59
Control	2.70 (0.33)	2.35 (0.38)	2 (40.0%)		
Intervention	3.57 (0.83)	3.73 (0.65)	7 (63.6%)		
Habit[b]				--	--
Control	2.10 (0.74)	1.90 (0.58)	0		
Intervention	2.43 (1.10)	2.50 (1.15)	4 (36.4%)		
Identity				3.22	0.20
Control	2.00 (0.94)	2.00 (1.00)	1 (20.0%)		
Intervention	1.91 (0.50)	2.55 (0.90)	8 (72.7%)		

Note. All table statistics calculated using per protocol analysis (intervention $n = 11$, control $n = 5$). Effect sizes were small ($\eta_p^2 = 0.01$), medium ($\eta_p^2 = 0.06$), and large ($\eta_p^2 = 0.14$) (Lakens, 2013).

*Significant at $p < 0.05$

[a]For implementation intentions, a decrease in score was considered “improved”.

[b]Not included in statistical analysis due to non-normal distribution of data.

Upon analysis, some marked differences in regulatory and reflexive M-PAC variables were determined that directionally supported plausibility for the efficacy of the

intervention. The intervention group largely differed from the control group at follow-up on behaviour regulation (η_p^2 = 0.46), emotion regulation (η_p^2 = 0.59), and identity (η_p^2 = 0.20). No other large effects were seen. Medium effects were also determined in support of intervention efficacy for intentions (η_p^2 = 0.13). All other effects were inverse to what was expected; beneficial behaviour change for PA engagement was determined among the control group on reflective factors. These included medium effects with respect to perceived capability (η_p^2 = 0.09) and perceived opportunity (η_p^2 = 0.06), plus some small effects for affective attitude (η_p^2 = 0.04). All other effects were negligible.

Positive directional changes are also seen individually among a number of intervention group participants. More than half of intervention group participants reported improvements on the behavioural measures of affective attitudes, implementation intentions, behaviour regulation, emotion regulation, and identity. This same degree of change was not reported for any of the behavioural outcomes among the control group participants. Less than half, but still more control group participants than intervention group participants, did report positive change for perceived capability and perceived opportunity. On all outcomes where large effects were seen between the intervention and control groups, and these differences were in favour of the intervention group, a greater number of intervention group participants over control group participants reported individual improvements.

Discussion

This study was a randomized, pilot trial testing the feasibility of a 10-week PA intervention among young people ages 19-30 with low mood and/or mild to moderate depression not meeting Canada PA guidelines (Ross et al., 2020). The intervention was

theory-based (M-PAC) online PA intervention featuring psychoeducational lessons, as well as exercise classes, and coaching geared towards increasing MVPA levels. Primary outcomes related to feasibility (recruitment, retention, and acceptability) and secondary analyses of outcomes related to change in depression symptom severity and amount of MVPA were conducted. A tertiary analysis of M-PAC framework constructs related to PA engagement was also performed.

Feasibility Outcomes.

The recruitment rate was 26/120 (21.7%), and this does not meet the a priori criteria for feasibility set out for this trial. I recommended that a reasonable recruitment rate for this trial would be 65% or greater in order to justify proceeding with a full-scale RCT. This was based on a number of trial considerations in the fields of behavioural sciences, PA and mental health, as well as reviewing criteria established in related feasibility and pilot trials, and RCTs (Firth et al., 2016; Jackson & Waters, 2005; Kerr et al., 2007; Lederman et al., 2020; Mailey et al., 2010; Sylvia et al., 2013). Despite precautions (e.g., considering attrition specifically among psychiatric populations; Firth et al., 2016; Sylvia et al., 2013), the resulting recruitment rate was still considerably lower than recommended. In particular, this is low in comparison to similar trials of online PA interventions for individuals with depression (Kerr et al., 2007; Mailey, et al., 2010); trials that heavily informed the recruitment rate recommendations here. For example, Kerr and colleagues reported a high rate of ineligibility at pre-screening at 58%, however they still managed to recruit a sample of 47 out of 112 interested individuals with depression. This accounts for a recruitment rate of almost double that of this study. Recruitment rate for this trial is also surprising considering the full and enthusiastic feedback youth shared regarding interest and demand for this intervention in study 1.

Overall, it is clear in reviewing related literature that the recruitment rate for this trial was very low.

A major finding with respect to feasibility was the lack of recruitment via clinic partners in community care. This trial was designed to have considerable recruitment occurring by way of physicians and allied health providers at two community-based primary mental health care clinics in Greater Victoria, BC; however, only a single participant was recruited through these means. Though there have been calls for intervention integration with primary and community care (e.g., Stathopoulou et al., 2006), this was evidently not feasible in this case. It is possible there is a lack of clinician interest to support this research, particularly given the focus on behavioural medicine which may be seen to fall outside of their practice. The lack of education and training in exercise among physicians (Cardinal et al., 2015) may be partly to blame for this possible perspective. However, I suggest this outcome is more likely related to the present crisis that exists within the BC primary and community care system (Esler, 2022). Physicians have made it very clear that they are struggling due to a lack of support, resources, time, and compensation (Esler, 2022). Considering strained capacity throughout the period of study, it is very reasonable to imagine that experimental research initiatives may have been lower priority. The study protocol also did not allow for any direct referral, so this recruitment outcome is likely to be a result of combined clinical capacity and population-specific factors. Importantly, community and primary care clinicians are ideally positioned to provide exercise prescription, thus making more research into integration and collaboration with these system stakeholders priority.

There are a number of additional factors which may be associated with the low recruitment rate, including the recruitment period and methods, and the special population. Recruitment occurred over a 5-month period from February through July. It was reported that the monthly recruitment rate trended consistently downward, apart from a spike in the last month. The rate declined steadily from 33.3% initially (March), all the way to 0% (June). This despite consistent advertising from the start to the endpoint of the recruitment period. As such, it is possible that the study had reached a saturation point in the recruitment sites being used. It is also plausible that given this study took place in Canada, recruitment rates shifted with the seasons, from winter to summer. It is well-established that weather and daylight hours are implicated in shifts in PA levels as well as moods (Glowacki et al., 2017). As such, the need or interest for PA-related research may have been reduced in the latter months of recruitment. Another possible explanation for a low recruitment rate is the stringent recruitment criteria with respect to age. For example, Kerr and colleagues (2008) recruited adults age 25-65 for their web-based PA for depression intervention. They achieved nearly double the recruitment rate as compared to this study. Interestingly, considering the 33 individuals aged 30-70 years who expressed interest in participating in this trial, age criteria likely played an important factor in recruitment feasibility.

The retention rate in this trial was low at 61.5% (16/26), and did not fall within the progression range. I recommended that 70% or greater would be a feasible retention rate for this trial to progress to a future RCT. This recommendation took into account relevant PA and mental health research describing retention rates for similar feasibility trials (Firth et al., 2016; Lederman et al., 2020; Lee et al., 2014; Pelletier et al., 2005;

Ramji et al., 2021; Sylvia et al., 2013). In particular, considerations for similar designs, as well as samples with mood-related mental health diagnoses and/or of young adults were considered (Kerr et al., 2008; Lederman et al., 2020; Mailey et al., 2010; Sylvia et al., 2013). However, it is important to consider that findings regarding recruitment in these studies were mixed. For example, Kerr and colleagues (2008) found a notably lower retention rate of 64% for their activity-based intervention pilot trial among adults with mild to moderate depression utilizing a variety of web-based and telephone supports similar to this one. Alternatively, Mailey and colleagues (2010) had a 91% retention rate in their pilot among college students with depression. Furthermore, considering this outcome in light of study 1 findings around integration, it makes sense that further strategies for retention may be needed; youth had little feedback to offer and this aspect of the intervention was not bolstered prior to trial. Even with more flexible criteria, data from this trial does not support feasible retention.

A number of factors may have contributed to the lower retention rates and attrition that occurred over the course of this trial. First, there was approximately 10% more attrition among control group participants, particularly at the stage of post-study follow-up. Despite being a popular control group method in the social sciences, there is some research to indicate that the waitlist approach may put retention at risk (Kinser et al., 2013). This perhaps suggests that individuals with various levels of depressive symptomology, even in the low mood and mild-to-moderate range, could benefit from more urgent access to intervention approaches. Researchers conducting future trials may wish to look at examples like Nystrom and colleagues' (2017) web-based PA trial among depressive adults which successfully used a behavioural activation control group. In

addition, retention challenges may be related to issues already explored with respect to recruitment. For example, the study period may have been a factor. As this trial progressed, most participants experienced a noticeable shift from winter to summer weather and daylight hours. The implications of this shift may be far reaching, impacting things like PA, mood, social engagements and more (Crocker et al., 1997; Patten et al., 2016; Peiser, 2008).

Considering feasibility outcomes in this trial, it is very important to note the implications that the changing COVID-19 pandemic context. In Canada, many social and travel restrictions began to lift in the spring of 2022. For example, the BC indoor mask mandate was lifted on March 11, 2022 (Hasegawa, 2022). This is just one of many COVID-related changes which likely impacted study recruitment and retention considerably, particularly given the online approach of this trial. It is very reasonable to imagine that, after two years of restrictions, participants were feeling fatigued by online approaches and looking for more social and in-person health promotion opportunities. All of these factors pose potential conscious or subconscious shifts in participants' interest, willingness or capacity to participate in the trial.

Upon analysis of fidelity data, it was determined that there were large disparities between participants with respect to their level of online engagement. There was a large range in participant outcomes on measures of total hours spent on the psychoeducational lesson pages and page views. Issues of participant engagement and adherence to interventions are not uncommon; in fact, these are ongoing challenges that behavioural researchers face. For example, Lambert and colleagues (Lambert et al., 2018) reported very comparable online usage data for their behavioural activation and PA intervention

pilot trial to that of this trial. A similar rate of roughly 50% of intervention participants were considered sufficient users of the online lessons. Another finding from the usage data from this trial was the considerably higher engagement seen in the first half of the intervention. Again, this is a phenomenon reported in other activity-based intervention research, particularly online (e.g., Hollman et al., 2022, Lambert et al., 2018). As mentioned previously, timelines in this study had participants moving steadily into better weather and more daylight hours as the intervention progressed, which could have been a major contributor to a lack of online engagement for some. This coupled with loosening COVID-19 restrictions quite possibly had major implications as this trial progressed. Altogether, this raises questions of how best to support participants to engage with online intervention materials, and maintain interest and motivation as they go through.

Levels of acceptability in this trial met criteria for recommendation for RCT. The acceptability of the check-ins was quite comparable to findings from related research. Generally, Mohr and colleagues (2013) suggest in their review that coaching and support from professionals tends to improve feasibility outcomes for web-based approaches. Mailey and colleagues (2010) found high satisfaction among college students with depression for monthly meetings coupled with their web-based PA intervention site. These researchers also reported good ratings of satisfaction very comparable to those seen in this trial. Furthermore, sufficient users in this study reported good ratings of acceptability for the lessons. Hollman and colleagues (2022) used the same 10 lessons adapted from the existing alpha-, web-intervention built using M-PAC framework (Liu et al., 2019), but found lower satisfaction among their sample of new moms. This may indicate the salience and relevance of psychoeducation on PA behaviour and mood for

individuals with low mood and depression. All of these acceptability findings, but particularly overall satisfaction, were reflected in the qualitative process evaluation feedback. For example, interview participants repeatedly shared their enjoyment as research participants. This theme has frequently been discussed in PA and mental health literature (Mason & Holt, 2012). Altogether, levels of acceptability from this trial suggest that those who participated in the various intervention techniques found them acceptable, and all participants tended to enjoy their overall experience being involved in research.

One unique theme captured in the qualitative feedback, but not explored through the quantitative process evaluation, was that of the barriers to PA participation. Participants expressed a variety of barriers such as finances, weather, social support, safety concerns, and more. Again, this theme, and many of the particular barriers participants mentioned, recur often in depression literature (Glowacki et al., 2017). It is interesting to consider these findings in light of literature exploring the issue of attribution to barriers versus excuses to be active (Brawley, Martin, & Gyurcsik, 1998). Such research may be particularly relevant considering this intervention provided resources whereby a variety of activities (and arguably, the entire intervention) could be completed entirely for free from home. Such findings and context may also validate motivational challenges among this population. Importantly, regardless of the nature of these barriers, strategies to support participants to overcome these are clearly needed.

Feasibility Recommendations.

Based on findings of feasibility in this trial, I would not recommend that this research be moved forward into a full-scale RCT study as an immediate next step. Given lower than expected rates of recruitment, retention, and platform usage, it is clear that there are improvements that can be made to the research methods prior to proceeding.

Future pilot research may also benefit from strategies focused on improving recruitment and retention in particular. Importantly, this study found that there was a very clear need to improve engagement with community partners and clinicians, given the lack of community-based recruitment. Having at least a few outcomes based around clinical integration and the benefits and challenges of this approach may have yielded a better understanding of providers' and patients' experience with recruitment. In addition, it is important to continue to build awareness for complementary resources like "The Exercise and Depression Toolkit" (Glowacki & Faulkner, 2019), which may help to educate and support providers and patients to better understand how exercise can practically be incorporated as part of treatment. Overall, improved engagement strategies are clearly warranted to integrate activity approaches with clinical services. In regards to the recruitment period, I recommend ensuring there are ample resources (e.g., human, financial, etc.) available to support recruitment, particularly for the longer duration that may be necessary to involve young adult and clinical populations. This could include multi-site efforts across multiple cities in order to increase reach. To further bolster against seasonal and time-based recruitment challenges, researchers may wish to explore how they can diversify, and possibly even periodize their use of various recruitment channels. Altogether, these are strategies which in the context of this trial, may have bolstered the recruitment rate and overall feasibility of the trial.

While a focus on recruitment is paramount, retention strategies will also be important to the success of future trials. Researchers with criteria that invites individuals with even sub-threshold low mood and mild mental health concerns to participate should consider how a waitlist control condition might compound motivational challenges.

Furthermore, a waitlist condition may also prolong challenges which otherwise could potentially be improved or resolved through the intervention. It goes without saying that even experimental intervention trials in preliminary testing phases (Czajkowski et al., 2015) should have considerable evidence backing their potential efficacy, and can result in some noteworthy results linking to efficacy. As such, I suggest that researchers looking to conduct future feasibility and pilot trials among populations with mental illness consider how they might incorporate active control conditions when possible. Other suggestions like offering substantial honoraria based around study completion, or other incentives, may be straightforward and proven strategies to bolster against attrition (Pope & Harvey, 2015).

Participant adherence to interventions is another ongoing challenge, and one which I suggest warrants considerable attention in future web-based research. Some past trials of online behavioural interventions have included what they refer to as "minimum doses". For example, Lambert and colleagues (2018) took a similar online, lesson-based approach, and used a minimum dose of two weeks of intervention content (i.e., two lessons). Interestingly, they also frontloaded their intervention content, tools and resources. This approach may not fully address adherence throughout a trial, but may be particularly helpful for trials further along the ORBIT spectrum (Czajkowski et al., 2015), where efficacy and effectiveness become priority outcomes. Additionally, I suggest that added social support throughout the intervention, but particularly during latter stages, might benefit participant adherence. The growing body of evidence specific to people with depression is beginning to suggest the importance of social support to this group (Glowacki et al., 2017; Mason & Holt, 2012), particularly during high stress and

isolation events like the global Covid-19 pandemic (Hou et al., 2021). While the online environment and staggered participation can make this suggestion more challenging to implement, there are options. Researchers have found online forums and other low barrier social supports to be beneficial, particularly among youth with depression (Horgan et al., 2013). Lastly, findings from this trial demonstrate the importance of fidelity measures in pilot research. Past trials have inconsistently included such measures (Sineath et al., 2017). While inclusion in itself is important, improving standardization and rigour with respect to these outcomes, particularly for digital health research, may be warranted. For example, Sineath and colleagues (2017) report a rigorous fidelity monitoring plan for their telehealth delivered intervention, and plans like this may be helpful in future studies. Overall, burgeoning online approaches provide a creative backdrop from which to think about strategies to monitor and support greater adherence among research participants.

Secondary Outcomes.

Despite the low feasibility scores within this study, there were some evident markers of plausibility among the secondary outcome data for PA behaviour. Effect size calculations indicated that the intervention group had larger improvements in MVPA from baseline to follow-up in comparison to the control group ($\eta_p^2 = 0.55$). This value can be interpreted alongside additional data markers which indicated some possible benefit to the intervention group over the control group. For example, 54.5% versus 0% of the control group self-reported meeting Canadian PA guidelines (Ross et al., 2020) post-intervention. These findings are not unexpected, as generally interventions providing psychoeducation and employing a variety of evidence-based BCTs have been quite successful in promoting MVPA among participants (McEwan et al., 2019). This suggests

that, compared alongside primary outcome results, this intervention may be quite acceptable and efficacious when participants can be recruited and retained.

Results in favor of intervention group participants were also reported on the secondary outcome of depression symptom severity (η_p^2 =0.18). Percent change and MCIDs were also excellent plausibility markers. A total of 90.9% of the intervention group participants reported some (i.e., any degree of) improvement, compared to 40.0% of the control group participants. Additionally, 72.7% of those receiving the intervention met accepted MCID levels (i.e., a PHQ-9 score of ≤10 and ≥50% improvement; McMillan et al., 2010), whereas none of the control group participants reported such marked change. Among those intervention participants meeting original MCID change benchmarks, 62.5% also met criteria for more stringent MCID recommendations (i.e., a PHQ-9 score of ≤13 and ≥50% improvement; McMillan et al., 2010). These outcomes echo findings relevant to efficacy determined in related pilot trials. For example, Mailey and colleagues' (2010) conducted a 10-week online pilot trial with similar BCTs exploring PA and depression symptom severity as primary outcomes. They determined a significant change in PA, and a non-significant but evident decrease in depression among those participants who increased PA. These results indicated some encouraging and meaningful group-specific changes in depression, and do suggest potential intervention benefits if participants can be retained.

Findings related to the secondary outcomes were encouraging, and researchers conducting future trials may look to confirm and extend these findings. I suggest that researchers consider exploring PA outcomes using higher quality measurement tools. Given known variability in self-report versus objective measurements of PA (Prince et

al., 2008), it will be important to confirm potential intervention effects. Also, longitudinal follow-up at six months or more would also add to understanding of the efficacy of this intervention approach. With good evidence for efficacy, it is suggested that researchers consider how best to build on these findings in subsequent research.

Tertiary Outcomes.

According to the M-PAC framework (Rhodes, 2017), this trial targeted participants with some intention to engage in PA, demonstrated by their interest and follow-through to participate in the intervention. As such, it was expected that scores on reflective and regulatory contructs, including perceived capability and perceived opportunity as well as behaviour and emotion regulation, would increase in association with rising PA levels. Regulatory constructs, including behaviour and emotion regulation, were expected to increase concurrent with intention decrease. Furthermore, given the length of the intervention, some improvement in reflexive variables was expected, but it was believed that these would be small.

The tertiary outcomes of regulatory and reflexive outcomes of PA behaviour change showed meaningful differences for intervention group participants. Analysis determined that intentions and regulatory variables had expected outcomes. Large effects were determined in favor of the intervention group on each of behaviour regulation (η_p^2 = 0.46) and emotion regulation (η_p^2 = 0.59). Medium effects in favour of the intervention group were found with respect to intentions (η_p^2 = 0.13), with 63.6% of the intervention group reporting improvement. This compared to improvement among only 40.0% of control group participants. Notably, large effects for identity (η_p^2 = 0.20) also favored the intervention group. These findings are supported by previous literature by Hollman and colleagues (2022) in trialing their web- and M-PAC based intervention. They also

reported some of the highest effect sizes for regulatory variables, with medium effects for reflexive outcomes over 10 weeks. Specific to research among those with depression, these findings might be particularly noteworthy, as adults with depression have been seen to face difficulties with volitional behaviours like behaviour regulation (Kramer et al., 2014). Altogether, these findings lend considerable support to the M-PAC framework approach among young people with low mood and mild to moderate depression.

Findings among the reflective variables were inverse to what was expected, and did not correspond with progression criteria. Though M-PAC framework theory suggests greater changes should be expected for regulatory factors like behaviour regulation, still some increase was expected for reflective outcomes among the intervention group. Instead, medium effects in favor of the control group were seen for each of perceived capability ($\eta_p^2 = 0.09$) and perceived opportunity ($\eta_p^2 = 0.06$). Both groups showed decline for affective attitude as well, but with larger declines seen among intervention group participants ($\eta_p^2 = 0.04$). Virtually no change on instrumental attitudes was seen and group differences were negligible ($\eta_p^2 = 0.00$). Looking again to research by Hollman and colleagues (2022), these findings are quite comparable to outcomes seen in their trial. These results may be explained to some degree by a “response shift” among participants (Campbell, 1957). There is ongoing debate regarding the psychological mechanisms and influences involved (Vanier et al., 2021), but research on response shift has generally shown that individuals engaging in health behaviour change may reappraise a construct with time and experience. In this way, participants may have had high initial hopes for the intervention, and thus inflated scores on reflective variables, but these may have declined with lived experience of the intervention. Importantly, Vanier and colleagues

(2021) highlighted the need for a minimum of two time points within a study in order to assess for a potential response shift. Additional follow up beyond 10-weeks would have provided more information by which to assess these discrepancies in target versus real-world changes. Consequently, the study design in this case limits any firm conclusions based on this phenomenon. In addition, these findings might be further explained by literature which has specifically focused on understanding motivation among those with depression. Though this research is limited, Kramer and colleagues (2014) recommended that outcome expectations might actually be a less meaningful construct for those with depression, particularly given the persistence of low action self-efficacy. Overall, these findings pose some interesting considerations for future research.

Researchers looking to conduct future intervention trials among those with depression using M-PAC framework should consider the differential utility of its' associated constructs. Findings from this trial indicate the importance of targeting regulatory and reflexive constructs among this special population. Researchers might consider, for example, moving the emphasis away from reflective topics as part of psychoeducational materials. This may be particularly important for researchers targeting those with existing intention to exercise. Overall, tertiary outcomes demonstrated good plausibility and do support the underlying mechanism of the intervention, and future exploration of M-PAC framework constructs among populations of young people with depression is warranted.

Limitations.

This research had a number of limitations. Namely, group comparisons are potentially biased by the unequal distribution of individuals with mild, moderate and severe depression severity to either the intervention or control group. On average,

intervention group participants reported moderate severity depression, versus mild among the control group (though this group difference was only by a separation of 3 points). It is possible that this had indeterminable impacts on various measures included in this trial. Importantly, both PA and depression severity were self-reported. Despite efforts to select valid and reliable measures for the study context, it is possible that factors like social desirability bias affected participants' responses. Furthermore, there was no formal follow-up (e.g., exit interview) with the various community clinical care services as part of this trial. Given the important finding that recruitment was limited via community partners, having formal evaluation focused on this aspect may have yielded important findings to aid future applied and integrated intervention research. Relatedly, follow-up with participants only occurred to 10 weeks, and additional longitudinal measurement of PA and depression over time could have resulted in a better understanding of intervention integration, and behaviour and mood changes for this population.

Importantly, a major limitation of this study was the COVID-19 context. This pandemic was an undercurrent that was no doubt a factor to some extent in the results and findings across all outcomes presented here. It is known that social activities, physical activities and mental health have been seriously negatively affected during this time (Mental Health Commission of Canada, 2020; Nelson & Kaminsky, 2020; Rhodes et al., 2020). As such, it is possible, for example, that this trial was open to a much larger population identifying with low activity and mood than would have existed just three years ago. From another perspective, many potential participants forced to work from home and take their social activities online may have been feeling tired and unmotivated by yet another online environment. As this study took no measures of COVID-related

outcomes, it is difficult to speculate on the perspective of participants and how this may have changed throughout the study. During data collection, public health advisories were frequently changing (Hasegawa, 2022), and it is very likely that this had sizeable impacts on change data throughout the intervention in particular (e.g., recruitment rates, retention rates). Overall, it is important to contextualize the results and findings of this trial in this global event.

Conclusion

The primary aim of this study was to evaluate the feasibility of a theory-based, online PA intervention for young adults with low mood and depression. Secondary and tertiary outcomes related to PA behaviour, depression symptom severity, and predictors of PA engagement, adherence and maintenance were explored. Inactive individuals age 19-30 who identified with experience of low mood, or mild to moderate depression were recruited online between February and July of 2022, and randomized to either an intervention or waitlist control group. Based on a sample of 26 participants, outcomes of feasibility in this study were lower than the recommended progression ranges. Recruitment and retention rate did not meet a priori established lower limits. Acceptability was sufficient, but based on a reduced subset of those participants who engaged in each of the relevant intervention components. An exploratory analysis of web usage data indicated a need to include rigorous measures of fidelity and bolster intervention adherence in future trials. As a result, this trial could not be recommended for RCT based on the existing study protocols and methods. Secondary outcomes of the amount of MVPA and depression symptom severity were noteworthy. Effect sizes between groups on each of these outcomes were large, and in favor of the intervention

group. A number of other related secondary outcomes of PA behaviour and depression including percent change and MCIDs indicated meaningful, directional plausibility for intervention efficacy. Tertiary outcomes also supported the potential benefit of the intervention for those participants that could be retained. Sizeable improvements for the intervention group on implementation intentions, emotion regulation, behaviour regulation, and identity were reported. Researchers looking to improve upon this trial in future should consider recruitment and retention strategies geared hard towards community-based populations of young people with depressive symptoms and threshold-level conditions. Overall, study findings suggest that more research is needed to understand the feasibility of online PA interventions among young people with low mood and depression, particularly those exploring integration with primary and community health services.

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Chapter 4 Discussion

The main objectives of this research were to: 1) iteratively adapt and target an existing online intervention using M-PAC framework (Rhodes, 2017) based on feedback from youth aged 19-30 with experience of low mood and/or depression who participated in online, semi-structured interviews, and to 2) evaluate the feasibility of the adapted beta-intervention compared with a waitlist control in a randomized, pilot intervention trial. This chapter provides an overview of the major findings and interpretation from both study one and two combined in the context of prior research, as well as recommendations for future research.

4.1 Situating the Thesis

PA is known not only to improve cardiovascular health and prevent over 25 chronic health conditions in the general population (Warburton et al., 2010), but also to prevent and treat depression. PA has recently been recommended as a first-line, mono- or adjunctive therapy for depression from mild to moderate severity (Ravindran et al., 2016). Despite this understanding, young people do not on average meet PA guidelines (Ross et al., 2020), and those with depression are known to experience further declines in activity (Helgadottir et al., 2015; Hiles et al., 2017). Theory-based PA interventions have been one approach successful at improving PA and depression outcomes (Josefsson, Lindwall, & Archer, 2014). Recently, online intervention approaches have been emerging to address longstanding challenges in the field like cost efficiency and accessibility (McIntosh et al., 2017). Some suggest that online approaches might also be more acceptable to younger generations who grew up using technology. While a growing body of evidence generally supports the effectiveness of such approaches, there are also a number of challenges like reach and retention (McIntosh et al., 2017; Mohr et al., 2013;

Wantland et al., 2014). Furthermore, these interventions often remain siloed in academia, rather than integrated within health services where they are desperately needed (Lederman et al., 2017). More research is warranted to better understand the feasibility of alternative, online, and theory-based intervention approaches integrated with mental health services. As such, this thesis examined the feasibility an existing online, PA intervention using the M-PAC framework (Rhodes, 2017) adapted for individuals ages 19-30 who identified with experience of low mood and/or depression seeking primary and community care services versus a waitlist control. This study extended prior work exploring the relevance and impact of applying action control theories to better understand PA engagement and its relation to the mental health of young people with depression (e.g., Kramer et al., 2014).

4.2 Study 1

Based on a mixed inductive and deductive reflexive qualitative analysis, the following themes and sub-themes were determined: acceptability (satisfaction, positive perceived effects, fit within culture, change ideas), demand (interest, intent to use, change ideas), practicality (likelihood of success, change ideas), and integration (perceived sustainability, change ideas). Interview participants (N = 7) reported good overall acceptability, demand, and practicality, and a few change ideas within each of these themes. Little feedback was provided with respect to integration, and no change ideas were shared. Ultimately, six change ideas were conferred and incorporated within the beta-platform for trial.

4.3 Study 2

This randomized, pilot feasibility trial could not be recommended for RCT based on the determined outcomes. Primary outcomes of recruitment rate recruitment rate (N =

26, 21.7%; 3.8% clinical) and retention rate (N = 16, 61.5%) did not meet progression criteria. This was despite sufficient acceptability for check-ins (n = 3, *M* = 3.67; 66.7% satisfied), lessons (n = 5, *M* = 3.73; 80.0% satisfied), and the study overall (n = 11, *M* = 3.73; 64.0% satisfied). On average, intervention participants' usage of the online platform was sufficient, at an average of 3.4 hours across the entire intervention period. However, an exploratory analysis revealed low adherence in a subset of participants, with over half (n = 6, 54.5%) determined to be insufficient users of the online lesson materials. Secondary outcomes including group differences and MCIDs favored the intervention group, and were determined to be good markers of probable intervention efficacy. This was true for both the outcome of PA (η_p^2 = 0.55), and depression (η_p^2 = 0.18). In addition, support for the M-PAC framework was determined considering between-group differences which favored the intervention group for each of emotion (η_p^2 =0.59) and behaviour (η_p^2 =0.46) regulation, and identity (η_p^2 =0.20).

4.4 Situating the Results in the Literature

Findings from study one and study two are interesting to consider together in light of prior research. Where study one participants overall suggested that the intervention was in demand and practical, study two outcomes of recruitment, retention and adherence indicated otherwise. Importantly, there was some evidence to suggest that participants from study one couldn't fully speak to all aspects of the feasibility of the intervention based on their exposure during relatively brief interviews. Regardless, Mummah and colleagues (2016) suggest in IDEAS that the final step in this framework is not really a final step at all; rather, ongoing work to further refine and optimize the product is essential in web-based intervention research (p. 4). As such, I suggest that together findings from study one and two are not incompatible, and not indicative of deficiencies

in one or the other, but simply highlight the need to continue to iteratively develop what otherwise has been found to be a relatively efficacious and acceptable intervention approach.

Behavioural outcomes lend support to the intervention approach taken in this trial, as well as ideas raised in previous literature directly relevant to the challenge of PA engagement among youth with depression. Primary outcomes from study two, like retention, adherence and usage, supports potentially ongoing motivational challenges among this population. In this trial, tertiary outcomes related to reflective M-PAC framework variables may also be indicative of such a deficit. Evidence in support of this theory is growing (Goodall et al., 2018; Kramer et al., 2014), and is particularly concerning given what we know about rising levels of depression in youth (Rajkumar, 2020). Importantly, evidence of phenomenon like response shift was also present, but design limitations made drawing firm conclusions based on any of this evidence difficult (Campbell, 1957). Overall, this suggests a need to continue to investigate distinct reflective, regulatory, and reflexive factors relevant to PA behaviour in order to better understand their varied influence and utility in the development of interventions targeted to the unique needs of depressive populations.

4.5 Strengths and Limitations

This research had a number of strengths. This intervention was novel; it applied an online and theory-based intervention using the M-PAC framework. To my knowledge, this intervention approach has never been taken among young people with depression. It offered the ability to gain unique insights into PA engagement among this population, plus valid and reliable measures repeatedly tested in prior trials. In this sense, this study also builds on previous work using M-PAC, and the M-PAC-based online intervention

which has been adapted for use among other populations (e.g., Hollman et al., 2022). The iterative strategy using IDEAS (Mummah et al., 2016) taken to adapt the existing intervention was another strength. Importantly, youth with low mood and depression from the population of interest were engaged early on the iterative design and evaluation of this trial. Particularly given the focus on feasibility, this engagement was no doubt invaluable. Lastly, another major strength was the online modality, which engaged a diverse sample of interview and intervention participants, including those rural and remote.

This research also has a number of limitations. Importantly, this study was conducted during transitional periods during the Covid-19 pandemic. This timing and context no doubt had far-reaching impacts on the findings presented. The majority of these impacts are unknown, though it was suggested that this likely had implications for the primary outcomes related to the feasibility of this trial. In addition, all of the participants of this research were volunteers. As such, this sample may have had some level of self-selection bias. Further, those who participated in the intervention trial had to self-report their PA, mood, and other behaviours. It is very possible that scores on all of the measures involved in this trial were impacted by social desirability bias. This point also relates to the feasibility outcomes reported in both qualitative and quantitative process evaluations. It is very possible that participants felt some motivation to present themselves in a certain light on these study measures. Lastly, given that the research coordinator had the dual role of peer supporter (i.e., activity coach) during this study, it is possible that this also impacted social desirability bias among participants. This may have

been particularly true as the trial progressed, as some participants formed more of a relationship with the coordinator.

4.6 Future Directions

An immediate recommendation of this trial is for another phase II pilot stage trial (Czajkowski et al., 2015), rather than proceeding with an RCT. There were lower than recommended rates of recruitment and retention, plus low adherence determined via exploratory analyses. Researchers conducting future online, behaviour-based trials should aim to better understand issues of feasibility. In particular, more understanding related to the feasibility of integrating with mental health services is warranted. Beyond feasibility, the efficacy of this intervention was plausible and lends support for more research into behaviour-based and theory-based approaches. The M-PAC framework (Rhodes, 2017) was relevant for explaining changes related to PA engagement, and it is recommended this continues to be tested in future investigations among individuals with depression. Importantly, this framework gives additional information and insight into possible correlates and mechanisms of change associated with PA and mood, and ultimately, relevant to intervention optimization for behaviour change among youth with depression.

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Appendix A.

Study One Interview Questions

Question 1	1. Does this intervention platform interest you?
Question 2	2. Do all of the lessons seem relevant and appropriate to someone like yourself if you were to be seeking to incorporate more regular physical activity into your life? Is there anything you might suggest be modified, added, or removed?
Question 3	3. Is there any content, formatting, or other aspect that stands out to you as confusing, offensive, irrelevant, or unimportant?
Question 4	4. If you were to be part of a group using this online platform to work towards engaging in more physical activity, do you think you would need or benefit from additional support? If yes, what would an ideal form of support look like for you? What would the support focus on? What would be the mode of support? Who would you be receiving support from?
Question 5	5. Do you see this program being something you could incorporate into your daily life through to the end of the 10 weeks? Is there anything that could be modified, added or removed to increase your long-term success?
Question 6	6. Any further comments? You are welcome to write comments anonymously in the chat as well or to email the moderator. The moderator's email will be placed in the chat.

Appendix B.

Outline of Study One Feasibility Outcomes Mapped to Corresponding Interview Guide Questions

Interview Guide Question	Feasibility Outcome Assessed
Question 1 – expression of interest	demand (intent to use, interest)
Question 2 – relevance and appropriateness	demand, acceptability (satisfaction, appropriateness)
Question 3 – off-putting content/format	acceptability (satisfaction, appropriateness, fit within culture, positive/negative perceived effects)
Question 4 – additional support	practicability (participants' ability to complete)
Question 5 – incorporation and adherence	integration (perceived sustainability)
Question 6 – general feedback	any/all

Appendix B. Feasibility outcomes are based on the design considerations for feasibility studies as described by Bowen and colleagues (2009).

Appendix C.

Outline of Codes from the Study One Reflexive Thematic Qualitative Analysis

Major Theme	Subthemes
(1) Acceptability	*1a. Satisfaction* *1b. Positive Perceived Effects* *1c. Fit Within Culture* *1d. Change Ideas*
(2) Demand	*2a. Interest* *2b. Intent to Use* *2c. Change Ideas*
(3) Practicality	*3a. Likelihood of Success* *3b. Change Ideas*
(4) Integration	*4a. Perceived Sustainability* *4b. Change Ideas*

Appendix D.

Study One Change Ideas Conferred by the Research Team and Incorporated into the Beta-Website

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Design Theme	Change Idea	Change Incorporated
Acceptability	Modify graphical information (brighten up or remove).	Kept charts and graphs, but reviewed for readability; no changes.
Acceptability	Flip flop Lesson 1 and 2.	Lesson 1 changed to the Mental Benefits, and Lesson 2 is Physical Benefits.
Demand	Include holistic health information.	Clear written description incorporated in the "Welcome & How to" of what the intervention is and what it isn't, with specific comment on holistic health.
Practicality	More structured exercise support.	Invitation in the "Welcome & How to" to seek support when needed regarding more structured exercise. Added an "Activity Suggestions" section following each lesson, which includes some of the YouTube videos and/or tailored suggestions for outdoor or social activity considering that week's lesson content.
Practicality	Additional early intervention support for goal setting and planning.	Reviewed and determined to be adequate; no changes.
Practicality	Increase social support.	Addition of one more optional up-to-30 minutes Zoom coaching session intended to be scheduled early in the intervention (~week 2). Updated in all materials where applicable (e.g., emails).

Appendix E.

Study Two Primary, Secondary, and Tertiary Outcome Instruments Outline and Measurement Plan

Construct	Questionnaire/ Construct	Reference	Time point	# of items
Primary Measures				
Acceptability		(Cox & Rhodes, 2020)	T2	6
Study Satisfaction		(Cox & Rhodes, 2020)	T2	7
Fidelity	Participation, Usage	(Cox & Rhodes, 2020)	Continuous	NA
Secondary Measures				
Depression severity	PHQ-9	(Arroll et al., 2010; Fine et al., 2013; Ford et al., 2020; Kroenke et al., 2016)	T1,T2	9
Self-reported PA	Godin Leisure Time Exercise Questionnaire (GLTEQ)	(Godin & Shephard, 1985)	T1, T2	3
Tertiary Measures				
MPAC Construct	Affective and Instrumental Outcome Expectations	(Arbour-Nicitopoulos et al., 2014; Keer et al., 2014)	T1, T2	7
MPAC Construct	Perceived Capability	(Lithopoulos et al., 2022)	T1, T2	4
MPAC Construct	Perceived Opportunity	(Lithopoulos et al., 2022)	T1, T2	3
MPAC Construct	Intentions	(Arbour-Nicitopoulos et al., 2014)	T1, T2	2
MPAC Construct	Behaviour Regulation (Action and Coping Planning, Self-Monitoring)	(Sniehotta, Schwarzer, Scholz, & Schüz, 2005)	T1, T2	2
Emotion Regulation	Adapted from DERS-16	(Bjureberg, Ljótsson, Tull, Hedman, Sahlin, Lundh, … Gratz, 2016).	T1, T2	2
MPAC Construct	Identity	(Wilson & Muon, 2008)	T1, T2	4
MPAC Construct	Habit	(Gardner, Abraham, Lally & De Bruijn, 2012)	T1, T2	4
Sociodemographic variables			T1	12

Appendix F.

Baseline Questionnaire

Instructions: The questionnaire should take approximately 20 minutes. All information from the questionnaire will be anonymous during the data analysis and publication of study results. All data will be published as group data, and any data kept separate will be identified by an anonymized data ID number.

Demographic data (such as your age, income, etc.) as well as some questions regarding your medical history and experiences with physical exercise will be asked. This data is being used to confirm your membership to the community of interest (e.g., individuals with mild to moderate Major Depressive Disorder). It is also being used to provide context to group responses. Please skip any questions you do not feel comfortable answering. If you skip a question that is required to be eligible to enter the study, the research coordinator will connect back with you about missing information.

You may request further information regarding this study by contacting the lab at [X]; or by contacting Dr. Ryan Rhodes at [X]. In addition to being able to contact the researchers at the above emails, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Board at the University of Victoria (250-472-4545).

Thank you for your participation!

Section 1: Physical Activity and Mood

Physical Activity

For these next questions, we would like you to recall your average weekly physical activity done during a typical week in the last month. When answering these questions, please:
-Consider your average weekly physical activity.
-Note that the main difference between the three categories is the intensity of the activity.

Please write the average frequency on the first line and the average duration on the second line.

During a typical 7-day period (1 week), how many times on average do you do the following kinds of exercise during your free time:

1. **STRENUOUS ACTIVITY** (HEART BEATS RAPIDLY, SWEATING) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)
Times per week _____
Average Duration (in minutes) _____

2. **MODERATE ACTIVITY** (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular folk dancing, vigorous house-work and gardening)
Times per week _____
Average Duration (in minutes) _____

3. **MILD ACTIVITY** (MINIMAL EFFORT, NO PERSPIRATION) (e.g., easy walking, yoga, bowling)
Times per week _____
Average Duration (in minutes) _____

Mood
Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	**Several days**	**More than half the days**	**Nearly every day**
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself-- or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3

10. If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?
_____ Not difficult at all
_____ Somewhat difficult
_____ Very difficult
_____ Extremely difficult

Section 2: M-PAC Physical Activity Related Motivational and Intentional Constructs

The next set of questions ask about engaging in physical activities of **at least moderate intensity.**

Recall that moderate intensity physical activity refers to activities where you can talk, but not sing your favourite song, during the activity. With these activities you are working hard enough to raise your heart rate. On a scale relative to an individual's personal capacity, moderate intensity physical activity is usually a 5 or 6 on a scale of 0 to 10 (where 0 is resting and 10 is extremely hard). Examples include walking briskly (~ 3 miles/hr or 5 km/hr), water aerobics, bicycling casually, and tennis.

More intense activities include race walking, jogging, running, swimming laps, and heavy gardening (continuous digging or hoeing). This type of activity does not include walking casually to get somewhere. Remember that you may refer back to these descriptions if you need examples later in the questionnaire.

Affective and Instrumental Outcome Expectancies

For each pair of words use the scale to indicate which word best represents how you would complete the sentence below. A "1" represents that you completely agree with the word on the **left** and "7" represents that you completely agree with the word on the **right.**

For me, engaging in at least 150 minutes per week of physical activity of at least moderate intensity over the next week would be…

Boring	1	2	3	4	5	6	7	Interesting
Unenjoyable	1	2	3	4	5	6	7	Enjoyable
Harmful	1	2	3	4	5	6	7	Beneficial
Unpleasant	1	2	3	4	5	6	7	Pleasant
Exhausting	1	2	3	4	5	6	7	Energizing
Not Fun	1	2	3	4	5	6	7	Fun
Worthless	1	2	3	4	5	6	7	Valuable

Perceived Capability

1. I have the physical and mental ability to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

2. I have enough skill do the activities needed for me to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

3. I can handle the physical and mental demands of being regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

4. I am confident in my physical and mental ability to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

Perceived Opportunity

1. I have the opportunity to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

2. I could find a way to fit it in my schedule so that I am regularly aerobically physically active over the next ten weeks.

a. Strongly Agree

b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

3. I would have the chance to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

Intentions

To what extent is the following statement true for you?
"I **will try** to do at least 150 minutes per week of at least moderate intensity physical activity over the next week."

1	**2**	**3**	**4**	**5**	**6**	**7**

Definitely False **Definitely True**

To what extent is the following statement likely:
"I **aim to do** at least 150 minutes per week of at least moderate intensity physical activity over the next week."

1	**2**	**3**	**4**	**5**	**6**	**7**

Definitely False **Definitely True**

Section 3: M-PAC Physical Activity Related Volitional Constructs

Continuing to consider any **moderate to high intensity** physical activity, please respond to the following questions.

Emotion Regulation

1	2	3	4	5
Almost never	Sometimes	About half the time	Most of the time	Almost always
0–10 %	11–35 %	36–65 %	66–90 %	91–100 %

Please indicate how often the following statements apply to you by writing the appropriate number from the scale above (1–5) on the line beside each item.

1. When I am upset, I have difficulty controlling my behaviours. _____

2. When I am upset, I believe there is nothing I can do to make myself feel better. _____
3. When I am upset, I have difficulty thinking about anything else. _____
4. When I am upset, my emotions feel overwhelming. _____

Behaviour Regulation

Sometimes we use strategies to help us be physically active. Please use the following 5-point scale to answer the questions below.

1. I kept track of my physical activity in a diary or log over the last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
2. I made regular plans concerning "when," "where," "how," and "what" kind of physical activity I did last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
3. I made plans regarding what to do if something interfered with my engaging in physical activity the last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
4. If I did not reach an exercise goal last month, I analyzed what went wrong
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

Habit

Physical activity of at least moderate intensity, such as when walking or biking casually, or playing a leisure sport, is something …

1. … I do automatically.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

2. … I do without having to consciously remember.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

3. … I do without thinking.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

4. … I start doing before I realize I'm doing it.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

Identity

1. I consider myself an exerciser.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

2. When I describe myself to others, I usually include my involvement in exercise.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

3. Others see me as someone who exercises regularly.
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

Demographic Information

The last part of this questionnaire is needed to help us understand the characteristics of those participating in the study. All information is held in strict confidence and its

presentation to the public will be in the form of group data only, and will not be attached to any identifying information.

1. Age (in years): ____
2. Gender:
___ Male
___ Female
___ Transgender
___ Gender nonconforming
___ Other diverse gender identity
___ Prefer not to answer
3. Ethnicity/race (please place a checkmark before any/all that best describe you):
___ Caucasian
___ South Asian
___ Arab
___ Aboriginal people of North America
___ African American
___ Korean
___ Japanese
___ Filipino
___ Chinese
___ Latin America
___Other:_____
___ Prefer not to answer
4. What is the highest level of education that you completed? _____
5. What is your occupation? _____
6. What is your annual household income per year when both members of the household are working? (This is used for statistical purposes only)
___$35,000 or less
___$35,001 - $50,000
___$50,001 - $75,000
___$75,001 - $100,000
___$100,001 - $150,000
___$150,001 - $200,00
___More than $200,000
7. Do you currently have children living at home?
□ Yes □ No
8. Do you currently smoke cigarettes?
□ Yes □ No
If yes, how many cigarettes do you usually smoke a day? _____
If no, have you ever smoked cigarettes? □ Yes □ No
9. Has a close blood relative (e.g. a parent, brother or sister) ever had heart disease (e.g. heart attack, stroke, and/or angina) before the age of 60?
□ Yes □ No
10. Has a doctor, nurse or other healthcare practitioner ever told you that you have had the following: (please check all that apply)

Angina Y/N
Heart Attack Y/N
Stroke Y/N
Diabetes Y/N
If yes, what type? Type I/Type II/Gestational

Cancer Y/N
High blood pressure Y/N
High blood cholesterol Y/N
Osteoporosis Y/N
Osteopenia Y/N
Arthritis Y/N
If yes, what type? Osteo/Rheumatoid/Other (please specify):_____

Major Depressive Disorder Y/N
Other mental health illness (please specify):_____

11. In general, compared to other persons your age, how would you rate your health?
___Poor
___Fair
___Good
___Very good
___Excellent

12. Are you currently taking any medication for one or more chronic disease outlines above

□ Yes □ No

If yes, please explain: _____

13. How did you hear about this study

Please provide a brief description:

_____

Appendix G.

Final Questionnaire

Instructions: The questionnaire should take approximately 20 minutes. All information from the questionnaire will be anonymous during the data analysis and publication of study results. All data will be published as group data, and any data kept separate will be identified by an anonymized data ID number.

This questionnaire includes questions regarding your medical history, experiences with physical activity, as well as the study itself. This data is primarily being used evaluate any group changes from the start to the endpoint of the study. Please skip any questions you do not feel comfortable answering, while being as complete as possible.

You may request further information regarding this study by contacting the lab at [X]; or by contacting Dr. Ryan Rhodes at [X]. In addition to being able to contact the researchers at the above emails, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Board at the University of Victoria (250-472-4545).

Thank you for your participation!

1. Do you agree to participate? Y/N
2. Please enter your ID number: (this was provided by the research coordinator)_____
3. What is today's date?

Section 1: Physical Activity and Mood

Physical Activity

For these next questions, we would like you to recall your average weekly physical activity done during a typical week in the last month. When answering these questions, please:
-Consider your average weekly physical activity.
-Note that the main difference between the three categories is the intensity of the activity.

Please write the average frequency on the first line and the average duration on the second line.

During a typical 7-day period (1 week), how many times on average do you do the following kinds of exercise during your free time:

1. **STRENUOUS ACTIVITY** (HEART BEATS RAPIDLY, SWEATING) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance bicycling)
Times per week _____

Average Duration (in minutes) _____

2. **MODERATE ACTIVITY** (NOT EXHAUSTING, LIGHT PERSPIRATION) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular folk dancing, vigorous house-work and gardening)
Times per week _____
Average Duration (in minutes) _____

3. **MILD ACTIVITY** (MINIMAL EFFORT, NO PERSPIRATION) (e.g., easy walking, yoga, bowling)
Times per week _____
Average Duration (in minutes) _____

Mood
Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	**Several days**	**More than half the days**	**Nearly every day**
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself-- or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3
10. If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people? _____ Not difficult at all _____ Somewhat difficult _____ Very difficult _____ Extremely difficult				

Section 2: M-PAC Physical Activity Related Motivational and Intentional Constructs

The next set of questions ask about engaging in physical activities of **at least moderate intensity.**

Recall that moderate intensity physical activity refers to activities where you can talk, but not sing your favourite song, during the activity. With these activities you are working hard enough to raise your heart rate. On a scale relative to an individual's personal capacity, moderate intensity physical activity is usually a 5 or 6 on a scale of 0 to 10 (where 0 is resting and 10 is extremely hard). Examples include walking briskly (~ 3 miles/hr or 5 km/hr), water aerobics, bicycling casually, and tennis.

More intense activities include race walking, jogging, running, swimming laps, and heavy gardening (continuous digging or hoeing). This type of activity does not include walking casually to get somewhere. Remember that you may refer back to these descriptions if you need examples later in the questionnaire.

Affective and Instrumental Outcome Expectancies

For each pair of words use the scale to indicate which word best represents how you would complete the sentence below. A "1" represents that you completely agree with the word on the **left** and "7" represents that you completely agree with the word on the **right.**

For me, engaging in at least 150 minutes per week of physical activity of at least moderate intensity over the next week would be…

Boring	1	2	3	4	5	6	7	Interesting
Unenjoyable	1	2	3	4	5	6	7	Enjoyable
Harmful	1	2	3	4	5	6	7	Beneficial
Unpleasant	1	2	3	4	5	6	7	Pleasant
Exhausting	1	2	3	4	5	6	7	Energizing
Not Fun	1	2	3	4	5	6	7	Fun
Worthless	1	2	3	4	5	6	7	Valuable

Perceived Capability

1. I have the physical and mental ability to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

2. I have enough skill do the activities needed for me to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

3. I can handle the physical and mental demands of being regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree
h.

4. I am confident in my physical and mental ability to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

Perceived Opportunity

1. I have the opportunity to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

2. I could find a way to fit it in my schedule so that I am regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

3. I would have the chance to be regularly aerobically physically active over the next ten weeks.

a. Strongly Agree
b. Agree
c. Somewhat Agree
d. Neither Agree nor Disagree
e. Somewhat Disagree
f. Disagree
g. Strongly Disagree

Intentions

To what extent is the following statement true for you?
"I **will try** to do at least 150 minutes per week of at least moderate intensity physical activity over the next week."

1	2	3	4	5	6	7

Definitely False **Definitely True**

To what extent is the following statement likely:
"I **aim to do** at least 150 minutes per week of at least moderate intensity physical activity over the next week."

1	2	3	4	5	6	7

Definitely False **Definitely True**

Section 3: M-PAC Physical Activity Related Volitional Constructs

Continuing to consider any **moderate to high intensity** physical activity, please respond to the following questions.

Emotion Regulation

1	2	3	4	5
Almost never	Sometimes	About half the time	Most of the time	Almost always
0–10 %	11–35 %	36–65 %	66–90 %	91–100 %

Please indicate how often the following statements apply to you by writing the appropriate number from the scale above (1–5) on the line beside each item.

5. When I am upset, I have difficulty controlling my behaviours. _____
6. When I am upset, I believe there is nothing I can do to make myself feel better. _____
7. When I am upset, I have difficulty thinking about anything else. _____
8. When I am upset, my emotions feel overwhelming. _____

Behaviour Regulation

Sometimes we use strategies to help us be physically active. Please use the following 5-point scale to answer the questions below.

5. I kept track of my physical activity in a diary or log over the last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
6. I made regular plans concerning "when," "where," "how," and "what" kind of physical activity I did last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
7. I made plans regarding what to do if something interfered with my engaging in physical activity the last month
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree
8. If I did not reach an exercise goal last month, I analyzed what went wrong
    a. Strongly Agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly Disagree

Habit

Physical activity of at least moderate intensity, such as when walking or biking casually, or playing a leisure sport, is something …

1. … I do automatically.
    a. Strongly Agree
    b. Agree
    c. Neutral

d. Disagree
e. Strongly Disagree

2. … I do without having to consciously remember.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

3. … I do without thinking.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

4. … I start doing before I realize I'm doing it.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

Identity

1. I consider myself an exerciser.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

2. When I describe myself to others, I usually include my involvement in exercise.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

3. Others see me as someone who exercises regularly.
a. Strongly Agree
b. Agree
c. Neutral
d. Disagree
e. Strongly Disagree

Section 4: Evaluation of the Study (** IG only)

The first set of statements will ask you about the online lessons:

1. I was interested in completing the lessons most of the time

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

2. I found the lessons relevant and appropriate for my needs and goals

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

3. I used the tools and strategies provided in the lessons

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

The next set of statements will ask you about the check-in with the research coordinator:

1. The check-in helped to maintain my investment in the online platform

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

2. The check-in helped to increase my physical activity

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

3. There was sufficient time to discuss and review my experience with the research coordinator

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

Study Satisfaction
These last few statements will ask you about your satisfaction with the online platform and the study overall:
1. My needs were met by the intervention overall

Strongly agree	Agree	Neither agree	Disagree	Strongly

		Nor disagree		disagree

2. I would recommend the online platform to other people

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

3. I enjoyed being a part of the research study

Strongly agree	Agree	Neither agree Nor disagree	Disagree	Strongly disagree

4. Please provide any other additional feedback on the program and/or study that you think would be helpful to the researchers.

Appendix H.

Weekly Support Email Script Sample: Week Three

We are on to week 3 of the intervention program! At this point, your understanding of the benefits of physical activity has likely grown. Let's continue that growth as we look into factors known to impact your physical activity intentions and goals.

Lesson 3 is now available when you would like to continue learning about physical activity. The next lesson is ***Increasing Self-Confidence for Physical Activity***—and this topic will be another important one to set you up for success! Did you know that self-efficacy is one of the most persistent and strongest predictors of physical activity engagement and adherence!? Next week we'll talk tools for building self-confidence and increasing your motivation for physical activity.

Link to site: digitalhealth.uvic.ca

Keep up your commitment and enjoy this week's lessons!

Appendix I.

Reliability of M-PAC Framework Construct Measures

M-PAC Construct	Items	Baseline α	Follow-up α
Affective Attitude	5	0.770	0.908
Instrumental Attitude	2	0.526[a]	1.00
Perceived Capability	4	0.752	0.785
Perceived Opportunity	3	0.750	0.936
Implementation Intentions	2	0.859	0.925
Behaviour Regulation	4	0.681[a]	0.851
Emotion Regulation	4	0.795	0.870
Habit	4	0.897	0.929
Identity	3	0.711	0.801

[a]Below traditional 0.7 cut off (Pavot et al., 2010), but within modified cut off considering the number of items is < 10 (Pallant, 2001).