Mild Aerobic Exercise Impact on Cognitive Symptoms of Depression

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Author Note

I have no conflicts of interest to disclose.

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Abstract

The author of this paper researched the effect that mild aerobic exercise, as measured in average steps per day, had on cognitive symptoms of depression including attention/concentration, planning/organization, retrospective memory, and prospective memory, as well as mood/physical symptoms of depression, and satisfaction with life. The current study was a pretest-posttest control-group between-subjects true experimental design that had a convenience sample of 10 participants with diagnoses of depression receiving behavioral health services in a primary care medical center. Five participants were randomly assigned to a control group and asked to keep track of their steps per day, while five participants were assigned to an experimental group and asked to increase their steps per day as close to 10,000 steps per day as possible. Average steps per day were measured by the pedometer application Runtastic Steps, cognitive symptoms of depression were measured through the Perceived Deficits Questionnaire – Depression (PDQ-D), mood/physical symptoms of depression were measured through the Patient Health Questionnaire- 9 Item (PHQ-9), and satisfaction with life was measured through the Satisfaction with Life Scale (SWLS). A one-way analysis of variance (ANOVA) indicated no significant difference between average steps per day between the control group (M = 3,209, SD = 1,943.88) and the experimental group (M = 4,600, SD = 1,294.22), $F(1,9) = 1.77$, $p = ns$. A one-way multivariate analysis of variance (MANOVA) indicated no statistical significance between the independent variable of mild aerobic exercise on the dependent variables of attention/concentration, planning/organization, retrospective memory, prospective memory, mood/physical symptoms of depression, and satisfaction with life $V = .79$, $F(6, 3) = 1.97$, $p = ns$. Lack of significant results may be related to sample size rather than a lack of true statistical

significance between the variables. While no significant differences were found, participants, on average, had improvements across all three domains.

Keywords: depression, exercise, memory, attention/concentration, life satisfaction

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Chapter 1

Literature Review

Psychology and the treatment of mood disorders have progressed at an astonishing rate from the early days within the field. Treatment and research have grown and adapted to be able to understand and treat symptoms and disorders with increasing efficacy as well as evidence-based practice (Margison et al., 2000). Despite this progression, many psychological problems persist throughout the lifespan and are resistant to modern treatment means (Solbakken & Abbass, 2015). As psychology has grown and adapted, so have humans; our capacity for empathy, understanding, growth, as well as cyclical maladaptive patterns (Cuff et al., 2016; Wachtel, 2017). It is a calling within the field to be able to best treat the individuals presenting for treatment (Kazdin, 2008). Within this calling is the continued advancement of research into evidence-based practices that would enhance and expand formal treatment means. Exercise has been a recent focus of study to enhance best practices in the treatment of many psychological disorders (Smith-Marek et al., 2016). The impact of exercise on depression has gained interest within the field to enhance evidence-based practices as well as provide a renewed focus for functional and symptomatic remissions of this disorder (Edman et al., 2014; Greer et al., 2016).

Depression

Depression is a common psychological condition that has been postulated to impact ten percent of the population throughout the lifespan (Elliot, 1998). The American Psychiatric Association (APA, 2013) discussed that depression is one of the more prevalent psychological disorders with prevalence rates in the United States estimated to

be close to seven percent. More recent figures presented by the World Health Organization (2017) indicated that prevalence rates vary by age and region, with prevalence peaking in older adults aged 55-75, at seven and a half percent for females and five and a half percent for males, and more commonly occurring in African regions. The World Health Organization (2017) discussed that the total number of people living with depression in the world is 322 million, while half of this figure is represented by individuals living in South-Eastern Asia as well as Western Pacific Regions. Features common to depression have been defined by the APA (2013) as the presence of sad, empty, or irritable mood, which is accompanied by cognitive/somatic changes that significantly impact functioning. Depressive disorders are classified within eight distinctive psychological disorders including disruptive mood dysregulation disorder, major depressive disorder (MDD; including major depressive episode), persistent depressive disorder (dysthymia), premenstrual dysphoric disorder, substance/medication-induced depressive disorder, other specified depressive disorder, and unspecified depressive disorder (APA, 2013).

Major depressive disorder is the most common depressive disorder that the APA (2013) has characterized by the following:

> A subjective or observational report of feelings of sadness, emptiness, and hopelessness, that are categorized by a marked diminished interest in pleasurable activities, significant weight loss, insomnia or hypersomnia every day, psychomotor agitation, fatigue, feelings of worthlessness, diminished ability to think or concentrate, and recurrent thoughts of death/suicidal ideation. (p. 161)

Major depressive disorder is classified as a mood disorder with varying specificities and severities (Elliot, 1998). This classification often lends a focus to the mood-related symptoms that are most common with depression, which Riepe et al. (2017) classified as depressed mood, loss of interest, fatigue/low energy, and suicidal ideation.

Mood-related symptomology is the first-line target for the treatment of MDD. Riepe et al. (2017) discussed that psychiatrists and physicians focus on the decreased symptomology of depressed mood, irritability, ruminative thoughts, suicidal ideation, and increasing energy levels through the utilization of common screening measures such as the Hamilton Depression Rating Scale and the Montgomery-Asberg depression rating scale. Treating the symptoms of suicidal ideation are managed with high priority because suicide or suicide attempts are symptoms of relapse for this disorder (Schmitt & Falkai, 2014).

Suicide is one of the most severe consequences of psychiatric disorders with individuals suffering from depressed symptomology often presenting at a higher risk (Schmitt & Falkai, 2014). Angst et al. (2014) noted from the Zurich study, which analyzed the propensity of symptoms between anxiety and depressive disorders from 1978-2008, that suicidal ideation occurred within 40.5% of the population while actual suicide attempts occurred within 6.6% of the population by age 50. Suicide attempts were found to be more prevalent with women while suicides more common with men in western countries and cultures. Within Asian countries and cultures, women's suicide rates were found to be equal or to exceed those of men (Angst et al., 2014). Within women, most suicide attempts occurred before age 20 and were correlated with environmental risk factors including sexual abuse and low social support while increased

suicide attempts in men were correlated with characteristics to personality including anxious and depressive traits (Angst et al., 2014). Suicide attempts and ideation are severe symptoms of depressive disorders and the mitigation of, or decreased risk of harm, is an imperative part of treatment for these disorders and symptoms. Treatment of suicidal ideation in depression, while important, has created a predisposition toward the reduction of mood-related symptoms over cognitive symptoms of depression.

Symptoms in the criteria for MDD that are often not considered first-line treatment are cognitive symptoms. Individuals with symptoms of a major depressive episode/disorder suffer from a lack of concentration/attention, planning/organizational difficulties, as well as memory-related problems. Therapy and medications may have a positive impact on these symptoms; however, the reduction of the negative impact of cognitive symptoms often is not viewed with the same importance as mood-related symptoms in treatment.

While not given the same importance, cognitive symptoms persist in individuals with depressive disorders and cause significant distress in daily functioning. Many individuals with a major depressive episode have an impaired ability to concentrate, think clearly, and often struggle to make even minor decisions (APA, 2013). Cognitive deficits with depression are associated across the lifespan in children to older adults where, respectively, problems with declining grades may reflect cognitive difficulties, and a loss of memory may be misdiagnosed as early-onset dementia.

Cognitive Symptoms of Depression

Cognitive dysfunction in depression is associated with deficits in attention, nonverbal as well as verbal learning, working memory, short term memory, processing,

and processing speed, as well as problem-solving. These symptoms are core aspects of MDD and have been represented through deficits on neuropsychological test batteries when compared with healthy subjects. These symptoms are pervasive throughout depressive disorders and may improve with treatment, although can often still be detected even when other symptoms have gone into remission.

Elliott (1998) noted that cognitive impairment has been seen across broad ranges of cognitive domains in subjects with depression. These executive impairments are related to frontal lobe dysfunction in individuals with depression. Elliot (1998) noted that there is a difference between effort-full versus automatic processing tasks within cognitive dysfunction in depression; demanding tasks will be more sensitive to impact with individuals with depression (Elliot, 1998). Explicit memory, which is viewed as relatively effort-full, has been noted to be more impaired on patients diagnosed with depression than implicit forms of memory that are relatively automatic (Elliot, 1998).

Psychopharmacological Treatments

Psychopharmacology is often the first-line treatment choice for depressive disorders (Bruder et al., 2014; Lenz et al., 2015; Shilyanksi et al., 2016). Shilyanksi et al. (2016) researched whether this first-line treatment choice had an impact on the reduction of cognitive symptoms present with MDD. Cognitive symptoms related to poor cognition have been noted with poor anti-depressant treatment outcomes in depression, creating the need to understand treatment means and outcomes for these symptoms (Bruder et al., 2014). Shilyanksi et al. (2016) studied a randomized prospective trial of adult aged patients who met criteria for non-psychotic MDD. They researched three antidepressant medications (sertraline, escitalopram, and venlafaxine XR) for the impact on cognitive

symptoms of depression. Depression rates were measured using the Hamilton Depression Rating Scale – 17 (HRSD-17) and the 16-item Quick Inventory of Depression Symptomatology (QIDS-SR16) while cognitive deficits, including the cognitive domains of attention, verbal memory, response inhibition, executive functioning, cognitive flexibility, working memory, decision speed, information processing, and motor coordination were measured using the IntegNeuro battery (Shilyanksi et al., 2016); symptoms were measured pre-treatment and post-treatment.

Shilyanski et al. (2016) discussed a "trait-like persistence of, and absence of anti-depressant treatment efficacy for impairments in attention, response inhibition, verbal memory, information processing, and decision speed" (p. 9) at the conclusion of their research. Their results indicated that only a small percentage of participants showed broad cognitive improvements within all the treatment groups while the average change in cognition in the treatment groups was considered minimal compared to the overall cognitive impairment within all the domains (Shilyanksi et al., 2016). Despite improvements in functioning common selective serotonin reuptake inhibitors and serotonin-norepinephrine reuptake inhibitors did not have a significant impact on the cognitive symptoms of depression.

Novel antidepressants such as vortioxetine, a serotonin multimodal antidepressant, have shown promise for the reduction of cognitive symptoms of depression in older adults > 65 (Stahl, 2017). McIntyre et al. (2014) evaluated the efficacy of vortioxetine at 10mg and 20mg doses vs a placebo toward the impact of cognitive functioning in an adult population > 18 & < 65, with a diagnosis of MDD. Patients were randomized to vortioxetine at 10 mg, 20 mg, or placebo for an eight-week

double-blind study period. Cognitive functioning was measured using multiple neuropsychological assessments including the digit symbol substitution test, the Rey auditory verbal learning test, trail making test A/B, the Stroop test, the simple reaction time task, as well as the choice reaction time task. Cognitive domains measured included executive functioning, processing speed, attention, and memory. Participants were assessed at baseline as well as week one and eight of the study.

McIntyre et al. (2014) found that participants in both treatment dose groups of vortioxetine had significantly superior mean change of cognitive functioning from baseline measures to week eight assessment compared to the placebo group. Vortioxetine dosage groups had a noted improvement in all cognitive domains studied when compared to the placebo group. This study indicated the beneficial impacts of vortioxetine at 10 mg and 20 mg doses regarding cognitive functioning on a general adult population with MDD.

Research by McIntyre et al. (2014) indicated a promising impact of the antidepressant medication vortioxetine on cognitive symptoms of depression, although this medication may not be accessible to many individuals. Magovern and Degeorge (2015) discussed the cost of vortioxetine compared to other commonly prescribed antidepressants. Magovern and Degeorge (2015) discussed that a one-month supply of vortioxetine at a dose of "5mg or 10 mg per day would cost approximately $254 per month" (p. 326). Compared to other commonly prescribed medications such as duloxetine ($35 per month), venlafaxine ($15 per month), and fluoxetine ($4 per month) the cost is high (Magovern & Degeorge, 2015). While vortioxetine may provide a promising treatment effect for cognitive symptoms, it is currently priced out of many

patients' levels of care; has not been studied in patients with mild to moderate depression; and has not been on the market long enough for extensive longitudinal studies toward long-term treatment impact or reduction of symptoms (Magovern & Degeorge, 2015).

Therapeutic Treatments

Psychopharmacology is considered the first-line treatment of depression although does not represent the entirety of depression treatment. Psychotherapy and brief therapeutic modalities are often used to treat depression with mild-high treatment efficacy (Forman et al., 2007). Common treatment methods include cognitive behavioral therapy, acceptance and commitment therapy, brief dynamic therapy, dialectical behavior therapy, behavioral therapy, mindfulness-based cognitive therapy, and many more. Treatment benefits may vary depending on modality, symptom severity, treatment adherence, and the relationship between the therapist and client/patient.

Cognitive behavioral therapy (CBT) is an evidence-based approach to therapy that is focused on negative automatic thoughts as well as maladaptive schemas present in a patient's life and how they impact emotional states as well as behaviors. This form of treatment has strong efficacy with individuals diagnosed with depression in terms of helping them regain functioning and lower the impact of their symptoms (Forman et al., 2007). Similar to pharmacotherapy, cognitive symptoms are often not the first target of treatment. Mood and behavior related symptoms are often targeted as treatment goals at the onset of treatment, although research has indicated that cognitive symptoms of depression mediate treatment impact (Lam et al., 2014).

Research by Docteur et al. (2013) found that a possible benefit of CBT on patients with bipolar I disorder is the impact on explicit memory. These researchers discussed the

neurotoxic impact that past depressive episodes had on individuals with bipolar I disorder and the resulting impact on memory. Depressive, anxious, and manic symptoms were assessed along with explicit memory within a population of 68 bipolar I patients. Explicit memory was assessed through word recall tasks – particularly if there was a difference with emotional valence of recalled words compared with the overall, or the total number of recalled words (Docteur et al., 2013). After a 6-month group-CBT trial, Docteur et al. (2013) found that there was a significant impact concerning dysfunctional attitudes, as well as improved explicit memory in overall recalled words, and a reduction of memory bias toward negative emotional words recalled. Research has indicated that therapy, including CBT, has a beneficial impact on cognitive symptoms regarding bipolar depression, although the research has been limited on the impact of therapy on cognitive symptoms of depression (Lam et al., 2014). A recent meta-analysis indicated that CBT combined with exercise had a positive impact on individuals with chronic diseases suggesting that exercise may provide a positive impact on symptoms of depression (Bernard et al., 2018).

Exercise

Exercise has emerged as a popular topic of research in the field of psychology over the last couple of decades. Researchers have reviewed and researched the impact that various forms of exercise may have on a myriad of psychological symptoms and disorders including anxiety, trauma, stress, and psychological well-being (Smith-Marek, et al., 2016). Within the current interest, researchers have analyzed exercise as a standalone treatment, an adjunct, as well as an indicator of holistic well-being. Anxiety and stress responses have been popular topics within exercise psychology research and

have indicated significant clinical promise for brief, as well as extended exercises and exercise programs. Research has indicated that single episodes of aerobic activity may provide benefits toward initial emotional response and recovery from emotionally stressful periods (Bernstein & McNally, 2017).

Bernstein and McNally (2017) researched the impact that acute aerobic exercise had on emotional recovery to a subsequent stressor. The researchers hypothesized that exercise would have a positive impact on the way that people process emotional experiences and information while also specifically predicting that exercise would have a positive benefit toward attention, and ruminative thinking patterns. Participants within the study were subjected to stressful tasks that included solving verbal puzzles within specific time constraints, with 30% of the puzzles being unsolvable. Participants also completed math tasks in front of an examiner who indicated when wrong answers were given, without feedback. Participants were left in a room for five minutes by themselves after the tasks to measure rumination. Bernstein and McNally (2017) found that participants who ruminated more after the initiated stressor had more negative emotions than participants with lower ruminative scores. This negativity was depleted when an acute aerobic exercise session was included preceding the stressor. Bernstein and McNally (2017) discussed that a brief aerobic exercise following a stressor may "moderate the impact of negative emotions caused by stress or stressful tasks" (p. 565). No significant impact was found regarding acute exercise and cognitive performance or attentional abilities; while variations were present between exercise and non-exercise groups, they were not significant.

Single bouts of aerobic exercise appeared to have a significant impact on moderating the effect of negative emotions after an emotional stressor. Bernstein and McNally (2017) researched the impact of acute aerobic exercise in regard to a single stressor, while Mata et al. (2013) researched the protective impact of exercise on emotional responses when participants were faced with repeated stressors. Half of the participants had recovered from a major depressive episode and half had never been diagnosed with any pathology. Participants within their study viewed two video clips that had been indicated to induce negative mood (Mata et al., 2013). Participants were assigned to an aerobic exercise cycling group (mild-moderate intensity) or a control rest condition. Participants who were assigned to the aerobic exercise group, both recovered depressed participants and healthy never diagnosed participants, did not show an increase in levels of negative affect in response to the repeated stressor. Participants assigned to the control group who were recovered from an MDD "exhibited higher levels of negative affect after the second mood induction, suggesting sensitization" (Mata et al., 2013, p. 48). The research by Mata et al. (2013) provided an inclination that exercise may act as a buffer toward negative affect when presented with repeated stressors as well as a protective factor for individuals who are recovering or have recovered from a major depressive episode.

Exercise and Social Anxiety

Aerobic exercise has been correlated with stronger levels of positive affect and lower levels of negative affect following single and repeated stressors (Bernstein & McNally, 2017; Mata et al., 2013) as well as producing a significant impact on anxiety disorders and anxiety-related symptoms. Jazaieri et al. (2012) researched the impact of

aerobic exercise compared to mindfulness-based stress reduction on the impact of social anxiety disorder symptoms. The researchers did not find a significant impact between the two interventions in the reduction of clinical symptoms, although both methods resulted in a significant reduction in clinical symptoms as well as enhanced well-being within the participants (Jazaieri et al., 2012). Jazaieri et al. (2012) discussed the positive results of aerobic exercise in relation to the exposure aspect presented. Efficacy in popular anxiety treatments such as CBT is strong because of in-session exposure, which the aerobic exercise participants, in the present research, experienced through eliciting symptom sensations during exercise (perspiration, increased heart rate, respiration) common to social anxiety disorder (Jazaieri et al., 2012).

Exercise and Panic Disorder

Aerobic exercise has indicated positive results with social anxiety symptoms as well as symptoms related to panic or panic disorder (Gaudlitz et al., 2015). Gaudlitz et al. (2015) researched the impact that aerobic exercise, compared to low impact activity, would have on participants with panic disorder while also receiving co-occurrent cognitive behavioral therapy. The participants in the aerobic exercise group exercised three times per week for 30 minutes on a treadmill while participants in the low impact activity control group participated in a training program that incorporated low impact stretching and yoga; both exercise programs lasted for eight weeks. Gaudlitz et al (2015) found that there was a significant impact on the reduction of anxiety and panic symptoms for participants in the aerobic exercise group compared to the low impact activity-controlled group. No significant difference was noted in CBT outcomes, although individuals in the aerobic exercise group had a trend toward more significant

improvement in therapy, although not at the level of statistically significant. (Gaudletz et al., 2015). This study has provided an indication of the positive impact of high-intensity aerobic exercise providing a positive reduction of anxiety scores in participants diagnosed with panic disorder. While there was a significant difference between levels of activity and anxiety reduction, the low impact activity group saw a reduction in anxiety and panic scores providing an inclination toward the beneficial impact of exercise on anxiety and mood symptoms, regardless of intensity. (Gaudletz et al., 2015).

Exercise and Depression

Mood disorders are some of the more common psychological disorders present within the general population (Bijl et al., 1998). Research on the impact of exercise on mood disorders and symptoms has progressed in the last couple of decades with a renewed focus on the impact that exercise may have on depressive disorders and symptoms. Aerobic exercise at various levels was shown to be impactful for participants with anxiety disorders and symptoms, lending a positive view toward the impact it may have on depressive symptoms. Stress is a common factor that often precipitates many mental health-related issues and is involved with exacerbating symptoms related to depression (Puterman et al., 2010).

Puterman et al. (2010) researched the impact that aerobic exercise had as a buffer to chronic stress. They measured the impact that chronic stress created on the telomeric DNA at the end of the chromosomes. Chronic stress, which has been linked to depression, can impact health through the premature or accelerated aging of cells, as shown through telomeric length (Puterman et al., 2010). Puterman et al. (2010) found that "higher levels of perceived psychological stress were associated with shorter telomeric

length and that physical activity acted as a positive buffer to those participants experiencing stress in regard to telomeric length" (p. 3).

Stress, or more specifically oxidative stress, has been indicated to play an important role in depression. Schuch et al. (2014) discussed the impact that oxidative stress had on brain-derived neurotrophic factor levels (BDNF), a "widely used marker of neurogenesis, assessed through serum thiobarbituric acid-reactive substances (TBARS)" (p. 606). The researchers discussed that BDNF levels are decreased in patients with major depression and that aerobic exercise may have potential in the treatment of depression by targeting the oxidative stress system (Schuch et al., 2014). Schuch et al. (2014) discussed that long-term exercise has been shown to help decrease the oxidative stress system and increase antioxidant system defenses and that in individuals without depression regular aerobic exercise has been indicated to increase BDNF serum levels.

Schuch et al. (2014) researched the important topic of whether adding exercise to the usual pharmacological treatment of severely depressed inpatient participants would decrease TBARS serum levels and increase BDNF serum levels. Patients in the exercise group of this study exercised three times per week on various aerobic exercise platforms (treadmill, stationary bicycle) and had a target caloric dose measured by heart rate monitors; the intensity of exercise was based on their preference until target dose was achieved. Schuch et al. (2014) found that aerobic exercise at various intensities, three times a week, decreased the TBARS serum levels in patients with severe symptoms of depression after three weeks, no significant change was found with BDNF serum levels. Lack of BDNF serum changes was discussed as possibly being moderated by pharmacological use, as previous studies have discussed that anti-depressant medications,

such as citalopram, have moderated the impact that exercise may have on BDNF serum response (Goekint et al., 2011). While exercise did not have an impact on BDNF serum levels in this study, it did provide a positive association toward TBARS serum decrease in patients with severe depressive symptoms. This indicated that aerobic exercise at moderate levels, three times a week, had a positive impact on the maladaptive effect of oxidative stress (Schuch et al., 2014).

Oxidative stress and the relation to BDNF and TBARS serum levels are important variables in understanding the symptomatology of depression and treatment implications of exercise. The influence of serotonin on mood and cognition represents another important variable in understanding the symptomatology of depression. Jenkins et al. (2016) discussed the implications of serotonin on mood and cognition where "low serotonin levels contributed to a lowered mood state, however this should be in concert with a biological or genetic manipulation, producing a predisposition that interacts with lowered serotonin to decrease mood" (p. 55). The researchers also discussed how depleted serotonin causes cognitive impairments including reported deficits in episodic and working memory, and verbal reasoning, while tryptophan (an amino acid used to make niacin, melatonin, and serotonin) supplementation has been shown to have a positive impact on attention and memory (Jenkins et al., 2016).

Serotonin plays an important role in understanding the symptoms and treatment of depression. Young (2007) discussed the antidepressant and anxiolytic effects demonstrated with exercise in regard to mood. A large body of evidence cited by Young (2007) indicated:

> Fatigue during exercise is associated with elevated tryptophan and serotonin synthesis . . . which has supported the idea that exercise, including exercise to fatigue, is associated with increased plasma tryptophan and a decrease in the plasma level of branched chain amino acids leucine, isoleucine, and valine which inhibit tryptophan transport to the brain. (p. 396)

It was clear from the analyses that exercise was related to improved mood and that indications were present, although not certain, toward exercise increasing the firing rate of serotonin neurons in humans, as in animals (Young, 2007).

Heijnen et al. (2016) added to the neurological discussion of exercise and conferred the positive impact that exercise regarding physical (good) stress had on the body compared to psychological (bad) stress. The positive physical stress was associated with "increased inactivation of cortisol (active steroid) into cortisone (inert steroid), increased levels of anandamide (a neurotransmitter that binds THC receptors, an endocannabinoid), BDNF, and serotonin" (Heijnen, et al., 2016, p. 4). Heijnen et al. (2016) also detailed that aerobic exercise has been shown to increase dopamine levels in animal studies within the midbrain, brainstem, striatum, and hypothalamus thus hypothesizing, that exercise may be beneficial for mood, working memory, and mental flexibility.

Neurological studies have indicated that aerobic exercise at intensities above 60% have increased serotonin levels as well as provided a protective factor psychological stress on BDNF and TBARS (Heijnen et al., 2016; Schuch et al., 2014). Longitudinal research has also indicated that regular aerobic exercise may act as a protective factor toward the recurrence of depressive symptoms or against the initial onset of depressive

symptoms (Teychenne et al., 2008). Teychenne et al. (2008) researched the variables of duration and intensity of physical activity in relation to depressive symptoms. They found that shorter and longer durations of physical activity were related to a decrease in the likelihood of depression and that high levels of physical activity intensity were strongly associated with a decreased likelihood of depression compared to lower physical activity intensities (Teychenne, et al., 2008). Teychenne et al. (2008) discussed mounting evidence that suggested "even low doses of physical activity may provide a positive protective factor against symptoms of and diagnosis of depression" (p. 407).

The protective factor aspects of exercise on chronic and oxidative stress, as well as the initial onset of depression, has indicated the beneficial impact of exercise as a treatment enhancer or alternative for depressive symptoms and features. Doose et al. (2015) researched this factor to understand whether aerobic exercise would have a positive impact on the treatment of MDD combined with psychotherapy and/or pharmacotherapy. The researchers provided a physical exercise program for participants aged 18-65, which consisted of an eight-week, three-time weekly, one-hour long group aerobic exercise intervention that incorporated walking and running at participants' self-selected exercise intensities. Depression scores were measured using the beck depression inventory-II (BDI-II) and Hamilton depression scale, all individuals were diagnosed with a severe depressive episode/disorder; the intervention group was compared to a wait-listed allocated group. Doose et al. (2015) found that their results indicated a large effect size, Cohen's $d >= .08$, on Hamilton depression scale scores when compared to the control group; in clinical significance, the "participants in the intervention group would have been considered recovered" (p. 273). This research indicated that the self-selected

intensity of aerobic exercise may be a strong intervention tool to supplement treatment as usual (psychotherapy and/or pharmacotherapy) for individuals diagnosed with MDD (Doose et al., 2015).

Aerobic activity at moderate to high intensity has been shown to be effective in reducing depressive symptoms, as measured by depression symptom screeners, although this type of activity may not be possible for all the population. Previous research by Teicher (1995) indicated that activity level may play an important role in the treatment of depression, regarding daytime activity levels and depression severity. Averill et al. (2018) set to investigate the claim of daytime activity being correlated with depression severity using activity trackers within an inpatient psychiatric ward. The participants had a primary diagnosis of major depressive episode with both unipolar as well as bipolar disorder-depressed phase. Averill et al. (2018) discussed significant correlations between depressive symptoms and change in movement measured by actigraphy (scientifically validated activity watch) as well as the coin rotation task, a simple measurement of psychomotor speed. The researchers discussed that increases with activity ability have been noted as a biomarker for depressive symptoms and discussed how accurate ability to track movement within participants was critical to their results; there was no significant difference found with activity levels and depressive symptoms when activity was measured using Fitbit (Averill et al., 2018).

In summary, exercise has been indicated as a beneficial adjunct to psychotherapy and pharmacotherapy treatments for depression as well as a beneficial standalone treatment for mild to moderate levels of a major depressive episode (Young, 2007). With the growing amount of literature indicating exercise as a successful adjunct or treatment

means for mood/physical related symptoms of depression, researchers have begun to analyze the impact on cognitive symptoms of depression. It is important to have adjunctive or standalone treatment resources for individuals struggling with depression that will help reduce the cognitive dysfunction within MDD as these symptoms are particularly relevant for the functional adjustment as well as long term outcomes for these individuals (Brondino et al., 2017). Brondino et al. (2017) discussed that anti-depressant medications have not been significantly effective in the treatment of cognitive symptoms of depression "even when clinical depressive symptoms have begun to remit" (p. 286). These researchers further indicated that psychotherapies such as cognitive remediation therapy and cognitive behavioral therapy have only had a small effect size on the reduction of cognitive symptoms of depression (Brondino et al., 2017). Exercise is a promising intervention/treatment for cognitive impairment within depression and has recently gained attention within the field.

Exercise and Cognitive Symptoms of Depression

Researchers have studied exercise in regard to brain functioning and cognitive performance in the past; however, they have not specifically started to understand the impact on cognitive dysfunction within depression until the last decade. Colcombe et al. (2006) researched the impact that aerobic exercise had on brain volume in geriatric adults in regions associated with decline due to age. These researchers found that in adults aged 60-79 years those that participated in a six-month trial of aerobic exercise training program had a significant increase in both gray and white matter regions compared to participants placed in a non-aerobic exercise control group (Colcombe et al., 2006). This

increase in brain volume may be associated with mediating cognitive dysfunction in geriatric adult populations (Colcombe et al., 2006).

While exercise has been correlated with impacting neural plasticity, as well as brain volume, studies have been limited regarding the application of individuals diagnosed with depressive disorders or suffering from symptoms related to depression. Oertel-Knöchel et al. (2014) researched the impact of aerobic exercise on cognitive performance per the individual psychopathology of patients diagnosed with depression or schizophrenia. The study utilized aerobic exercise, cognitive training, as well as relaxation techniques within a 4-week timeline where 12 sessions at 75 minutes each were utilized. Oertel-Knöchel et al. (2014) indicated through their research that "depressive patients showed a significant improvement of cognitive performance in the domains speed of processing, working memory, and visual learning compared to the control group" (p. 600). The researchers did cognitive testing one week after the intervention and found a significant effect, indicating that physical exercise may enhance cognitive performance in participants diagnosed with MDD (Oertel-Knöchel et al., 2014).

Exercise has been indicated to have a positive impact on cognition and cognitive performance both in patients diagnosed with depression and in healthy populations (Colcombe et al., 2006; Oertel-Knöchel et al., 2014,). Eskilsson et al. (2017) researched whether these effects would carry over to populations that are impacted by stress-related exhaustion. Stress-related exhaustion has been characterized by pronounced physical and mental exhaustion that often impacts executive functioning, attention, concentration, as well as episodic and working memory (Eskilsson et al., 2017). This level of stress has been noted to have high co-morbidities with depression and anxiety and is often treated

with a multimodal rehabilitation therapy similar to cognitive behavioral therapy. Cognitive impairments often remain after individual treatment in patient groups, which highlights the need to understand interventions and treatment programs that specifically target cognitive symptoms (Eskilsson et al., 2017).

Eskilsson et al. (2017) researched the impact that a 12-week moderate-to-vigorous-intensity aerobic program would have on cognitive performance when combined with a multi-model rehabilitative program that used group tenets of cognitive behavioral therapy for participants experiencing stress-related exhaustion. Eskilsson et al. (2017) results indicated that individuals in the aerobic exercise group showed significant improvement in episodic memory indicated by a medium effect size. No significant results were noted between the exercise and rehabilitative program and the non-exercise control group regarding levels of burnout, depression, and anxiety. It is important to note that while no significant differences were noted in the previously mentioned categories, there was an equal improvement in both groups noted. Previous studies have noted a significant difference in adding aerobic exercise to treatment programs for individuals experiencing chronic stress and depression (Jenkins et al., 2016; Puterman et al., 2010). This current research has provided the inclination that aerobic exercise may have a positive benefit on memory-related cognitive deficits that are present with depressive symptoms (Eskilsson et al., 2017).

Research by Eskilsson et al. (2017) provided results that indicated that aerobic exercise at moderate to high levels of intensity was beneficial to participants memory although did not provide a significant difference for other levels of cognitive functioning, depression scores, or stress-related exhaustion compared to the non-exercise treatment

control. A recent meta-analysis conducted by Brondino et al. (2017) found similar results about the intensity levels of aerobic exercise. Brondino et al. (2017) evaluated the current research that looked to understand the effect of physical exercise on cognitive symptoms of depression. They found, surprisingly, that "pooled effect sizes of the current research did not show an effect in favor of exercise" (Brondino et al., 2017, p. 291). The intensity of the exercise (moderate-high), the number of sessions per week, as well as the length of follow up did not impact the null effect of aerobic exercise on cognitive symptoms present in patients diagnosed with MDD. Brondino et al. (2017) results did indicate, however, that the effect of low-intensity exercise and shorter follow up durations bordered on significance, providing the possible inclination that a lower number of exercise sessions per week with low-intensity exercises and shorter follow-ups may provide better outcome data for the impact of aerobic exercise on cognitive symptoms of depression.

While Brondino et al.'s (2017) meta-analytical research did not provide significant evidence toward the positive impact of aerobic exercise on cognitive symptoms of depression, it did provide direction for further study on low-intensity aerobic exercise for cognitive symptoms of depression. Research by Sims-Gould et al. (2017) sought to understand this effect by studying a community based participatory approach to physical activity and mental wellness. The researchers recruited 24 participants diagnosed with MDD or bipolar II disorder to conduct interviews related to understanding facilitators and barriers to mental health, strategies to improve health and quality of life, as well as the ideal physical activity program for individuals with mood disorders (Sims-Gould et al., 2017).

Of specific importance to the topic of exercise for cognitive symptoms of depression was the responses given to the question of features concerning an ideal physical activity program. Participants in Sims-Gould et al. (2017) study discussed that an ideal exercise program would include multiple components such as cardio and enjoyable activities, specific activities mentioned were walking, swimming, weightlifting, and yoga. The ideal frequency of an exercise program for participants with a mood disorder would be two to three times per week and incorporate light to moderate intensities for a duration of 30 to 60 minutes, while the availability of a free or low-cost program was indicated as ensuring successful participation (Sims-Gould et al., 2017). This research provided important information regarding a style of exercise program that would be beneficial, and most likely to provide significance for participants with mood disorders.

Research by Sims-Gould et al. (2017) discussed the benefits of providing participants with free, low-intensity, and fun exercise programs to benefit symptoms of depression and provide easy access to participants. Walking programs using steps per day has become a popular workplace intervention for mental health and wellbeing and fit the criteria discussed by Sims-Gould et al. (2017) research. A program developed by Hallam et al. (2018) entitled Happy Feet sought to investigate the impact of a 100-day, 10,000 step program on symptoms of depression and anxiety within 1,963 adult participants. The researchers studied differences in stress levels, depression, anxiety, and wellbeing present from baseline until the 100-day mark of the study. Depression, anxiety, and stress were measured and assessed using the Depression Anxiety Stress Scales (DASS), while wellbeing was assessed using the Warwick-Edinburgh Mental Wellbeing Scale

(WEMWBS; Hallam et al., 2018). Hallam et al. (2018) discussed significant findings with their results across all areas studied. The significant effect appeared regardless of the average steps attained by the participants over the training program. Hallam et al. (2018) discussed improvements in all baseline measures including "improved stress levels by 8.9 %, signs of depression 7.6%, anxiety by 5.0%, and wellbeing by 2.1%" (p. 5).

Significant improvements were noted within this study even though there were differences in steps achieved per day; effects were similar for those participants that walked over 10,000 steps per day and for those that walked under 10,000 steps per day. Research by Hallam et al. (2018) reinforced the benefits available to those that are focused on their wellbeing using a light intensity, free, aerobic exercise program. Brondino et al. (2017) indicated that a possible significance may be present for reducing cognitive symptoms of depression if research focused more on light intensity exercises with shorter follow up durations. Recent studies by Simms-Gould et al. (2017) and Hallam et al. (2018) have discussed how approachable light intensity aerobic exercise programs should be designed and how they can produce a significant impact on depression and wellbeing scores in large populations. This knowledge and previous research as cited in this review of the literature lay the groundwork for future studies looking to understand the positive impact that mild aerobic exercise may have on cognitive symptoms of depression with individuals diagnosed with MDD or experiencing significant symptoms of depression.

Rationale

Researchers, including Hallam et al. (2018), have projected that by the year 2030 mental illness, in general, will be predicted to cost the world six trillion dollars. This

figure would place the financial impact of mental illness well above other serious health issues. As one of the more prevalent psychological disorders, depression may play a large role in the projected fiscal amount. It is imperative within the scientific community to be able to have a robust understanding of not only the causes and contributing factors of depression but also the treatment. The focused approach of treatment that decreases the symptoms of depression as well as increases patient functioning is important to decrease the societal fiscal impact of depression and depressed symptomology.

Research of mood disorders, including depression, has advanced in recent years to best efficaciously treat this population. Evidence-based treatments including pharmacotherapy, cognitive behavioral therapy, acceptance and commitment therapy, as well as dialectical behavior therapy have found high treatment efficacy for depression within the last decade through continued research of treatment protocols (Forman et al., 2007). Unfortunately, antidepressants are minimally effective for reducing, specifically, cognitive symptomology of depression and psychotherapy has not been studied extensively toward the reduction of cognitive symptoms of depression (Brondino et al., 2017). Exercise has been indicated to be an effective treatment for mild to moderate depression as both an adjunct to psychotherapy/pharmacotherapy and/or as a monotherapy (Greer et al., 2016).

Cognitive symptoms and deficits in MDD are often still present in periods of remission and may act as a primary mediator of functional impairment in MDD (Lam et al., 2014). There is a need in the field to be able to study the impact that mild aerobic exercise may have on cognitive symptoms of depression to adjunct existing treatment and provide approachable interventions for the pervasive symptoms related to deficits in

attention, working and short-term memory, problem-solving, processing speed, and visual and auditory processing.

Sims-Gould et al. (2017) discussed parameters that participants diagnosed with mood disorders determined would strengthen exercise-based studies. Fun exercise-based activities such as walking were discussed along with the important factors of making the exercise approachable with a mild intensity, patient facilitated, self-selected pace (Sims-Gould et al., 2017). Hallam et al., (2018) researched how a 10,000-step challenge in a large population would impact mental health and mental wellbeing from baseline to 100 days later. The researchers found that regardless of the number of steps taken, > 10,000 or < 10,000, there was significant improvement among anxiety, depression, stress, and wellbeing scores.

The current study, which seeks to research the impact of mild aerobic exercise through increased step count on cognitive symptoms of depression in a primary care patient population, would be an important additive to the present literature to answer the questions presented by Brondino et al. (2017) of whether mild aerobic exercise would provide a significant impact on depression and cognitive symptoms of depression. The guidelines presented by Sims-Gould (2017) would be utilized to make an exercise intervention, as an adjunct to treatment as usual, presentable to the participants through free, attainable, mild intensity exercise. The research by Hallam et al. (2018) would be furthered to measure the impact on increased steps per day on a clinical population within a primary care setting.

Research by Stanton et al. (2014) indicated that general practitioners have a positive attitude regarding exercise toward the treatment of depression, although were

indicated to have low levels of confidence in prescribing exercise for the treatment of depression. This study would help to address the confidence problem in primary care facilities by providing further information on the treatment efficacy of mild aerobic exercise for depression. Stubbs et al. (2016) discussed that individuals with depression often engaged in lower levels of physical activity or exercise than the general population, despite the positive impact that exercise may have on depression symptoms. The present study would help address this issue by using a mild form of aerobic exercise, walking/steps per day, that is patient facilitated.

The independent variable being studied will be the number of steps per day that participants engage through self-selected intensities of walking. The dependent variables being studied will be cognitive symptoms of depression that will be encapsulated by attention/concentration, planning/organization, retrospective memory, and prospective memory, mood/physical related symptoms of depression, as well as life satisfaction, which will be the last dependent variable. These topics are important for study as they represent the core cognitive symptomology represented in depression. Studying the general mood/physical symptoms of depression through a common screener is important to understand a further impact between mild aerobic exercise and general depression symptoms.

The current research seeks to provide important information to the field as well as address the gap in the literature regarding the impact of mild-intensity aerobic exercise on cognitive symptoms of depression. Anti-depressants have not been noted as having a significant impact on cognitive symptoms of depression and psychotherapy has not had extensive study about its ability to address this need (Brondino et al., 2017). Cognitive

symptoms have been noted to have an important mediator impact on functional impairment within MDD, which makes the study of available interventions and treatments to help with these symptoms imperative (Lam et al., 2014). The purpose of the present study is to add to the body of literature that focuses on interventions and treatments for the cognitive symptoms of depression, specifically regarding exercise.

Research Question/Hypothesis

The research question for this current study is: Will increases in mild aerobic exercise monitored by a smartphone pedometer app at self-selected duration and intensities have a significant reduction on cognitive symptoms of depression represented through attention/concentration, planning/organization, retrospective memory, and prospective memory, while subsequently lowering PHQ-9 depression scores, while increasing satisfaction with life scores? The hypothesis will be:

H1: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on cognitive symptoms of depression domains as measured through a reduction of PDQ-D scores from baseline in the domains of attention/concentration, planning/organization, retrospective memory, and prospective memory.

H2: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on mood and physical symptoms of depression as measured in a reduction of PHQ-9 scores from baseline.

H3: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on participants' satisfaction with life as measured through increased scores of the Satisfaction with Life Scale from baseline.

Chapter 2

Research Methodology

The purpose of the current study is to address the gap in the literature in terms of how the variable of mild aerobic exercise measured by steps per day interacts positively or negatively with cognitive symptoms of depression including attention/concentration, planning/organizing, retrospective memory, and prospective memory, as well as general symptoms of depression and life satisfaction in a primary care patient population. The literature has currently indicated that mild aerobic exercise may have a significant impact on overall symptoms of depression through a trend noticed in a recent meta-analytic review by Brondino et al. (2017). Despite a lack of significant data regarding moderate to high-intensity exercise reducing cognitive symptoms of depression, a trend was noticed by Brondino et al. (2017) indicating the possibility that mild aerobic exercise at self-selected intensity and lengths could have positive interactions with cognitive symptoms of depression.

The current study will address the question of whether mild aerobic exercise measured through steps per day will have a positive impact on cognitive symptoms of depression as measured through PDQ-D scores as well as understanding the impact that mild exercise will have on mood/physical symptoms of depression and life satisfaction. The following hypotheses have been inferred.

H1: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on cognitive symptoms of depression domains as measured through a reduction of PDQ-D scores from baseline in the domains of

attention/concentration, planning/organization, retrospective memory, and prospective memory.

H2: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on mood and physical symptoms of depression as measured in a reduction of PHQ-9 scores from baseline.

H3: Increases in mild aerobic exercise close to 10,000 steps per day will have a positive impact on participants' satisfaction with life as measured through increased scores of the satisfaction with life scale from baseline.

Participants

The participants for this study came from a convenience sampling of 10 patients within a primary care system that had a diagnosis of MDD or elevated PHQ-9 screener scores that had been recorded for two months. Of this sample, four participants had a single diagnosis of a MDD, one participant had a diagnosis of an adjustment disorder with depressed mood, two participants had diagnoses of MDD and post-traumatic stress disorder, one participant had diagnoses of unspecified depressive disorder and post-traumatic stress disorder, one participant had co-occurring MDD and generalized anxiety disorder, and one participant had co-occurring MDD and panic disorder. This sample was comprised of adult individuals aged 29-58 and consisted of an uneven ratio of males to females where there were 2 males and 8 females who engaged with behavioral health services in a primary care medical setting. The average age of participants was 45 with five participants who identified as White/Caucasian, three participants who identified as African American, and two participants who identified as Latino/Hispanic.

Participants were assigned a number and randomly assigned to either the treatment group or the control group to decrease systematic bias in group assignment and to keep to the nature of a true experimental design. Participants were recruited in person by behavioral health professionals and were sent an email via Qualtrics survey platform with informed consent to the study. Communication regarding the study was through electronic mediums of email through the Qualtrics survey platform. Instruments were carried out on this platform at the beginning and end of the study, although some participants chose to print and manually fill out post measures and turn them into the researcher.

Participants were informed in person and in the informed consent form that they were free to discontinue at any point. Information was also provided at the end of the survey for each questionnaire regarding the 211 crisis hotline and the crisis connections 24-hour crisis line (866-427-4747) for information regarding resources if the participants believed that their information to the survey topic/s had been concerning or if they were experiencing increased suicidal ideation due to their depressed features.

Instruments

Four instruments were used within the confines of this study, including a standard demographic form (Appendix A), the Perceived Deficits Questionnaire – Depression (PDQ-D; Appendix B), the Patient Health Questionnaire – 9 Question (PHQ-9; Appendix C), and the Satisfaction with Life Scale (SWLS; Appendix D). The study also utilized an app-based pedometer, Runtastic Steps, developed by Adidas and available on Android, Google, and Apple smartphone devices.

The Perceived Deficits Questionnaire – Depression

The PDQ-D is a 20 question self-report measure that measures cognitive dysfunction in depressed individuals. The 20 questions investigate four domains of cognitive dysfunction including attention/concentration, planning/organizing, retrospective memory, and prospective memory. The original scale was developed by Sullivan et al. (1990) to assess the degree to which individuals with multiple sclerosis perceived themselves as undergoing cognitive difficulties. The questionnaire was later revised and adapted to be used specifically in populations with MDD as a measurement of the cognitive symptoms of depression (Fehnel et al., 2016). This questionnaire was later evaluated by Lam et al. (2018) for psychometric validation in the measurement of cognitive symptoms in adults with and without MDD. Internal consistency was indicated as high, and the PDQ-D was indicated as a "reliable and valid measure of subjective cognitive dysfunction in patients with major depressive disorder" (Lam et al., 2018, p. 2872). The four subscale scores range from 0-20 and with higher scores equaling greater perceived cognitive difficulties (Sullivan et al., 1990). Subscale scores are summed for a total PDQ-D score where a score of 40 or more is indicated with the threshold for risk range (Sullivan et al., 1990).

The Patient Health Questionnaire – 9 Question

The PHQ-9 is a 9-item screener commonly used to screen for depression symptoms in primary care. Scores on the PHQ-9 range from 0-27 with scores of 1-4 indicating minimal depression, 5-9 indicating mild depression, 10-14 indicating moderate depression, 15-19 indicating moderately severe depression, and scores of 20-27 indicating severe depression. The PHQ-9 was indicated as a valid measure for criteria-

based diagnoses of depression and deemed a valid and reliable measure of severity of depression (Kroenke et al., 2001). Arroll et al. (2010) also discussed the PHQ-9 as a valid measure within a primary care population and noted that scores of 10 or higher on this measure appeared to detect more "depressed patients than the originally described PHQ-9 scoring for major depression" (p. 352).

The Satisfaction with Life Scale

The Satisfaction with Life Scale (SWLS) is a 5-item scale that was designed to measure the global cognitive judgments related to participants' satisfaction with life (Diener et al., 1985). Participants indicate how much they disagree or agree with the 5 items through a 7-point scale which ranges from 1 *strongly disagree* to 7 *strongly agree*. While this measure is not a measure of positive or negative affect, research by Pavot at el. (1991) indicated that the SWLS was shown to be a reliable as well as a valid measure of life satisfaction. Pavot and Diener (1993) suggested the use of the SWLS as a complementary measure to screeners and measures focused on emotional wellbeing and/or psychopathology.

Runtastic Steps

Runtastic Steps is an app-based pedometer that has become a popularly downloaded app for tracking steps for fitness. Runtastic works by utilizing GPS on the smartphone and divides the distance traveled by stride length to calculate steps (Orr et al., 2015). While a study by Orr et al. (2015) indicated that Runtastic Steps did not meet the error threshold necessary to be considered valid or consistent for research, a more recent study by Presset et al. (2018) indicated that Runtastic Steps had a higher accuracy than a mechanical pedometer, especially at a walking pace of 2km/hr and 4 km/hr. Presset et al.

(2018) found that Runtastic Steps was well below the 3% error rate at walking speeds between 2 km/hr – 6 km/hr and was more consistent than the mechanical pedometer. The app had the highest accuracy when kept close to the body and strapped as tightly as possible and had the lowest accuracy when in a loose jacket pocket. Presset et al. (2018) discussed the new possibility for using this app-based pedometer for research trials involving walking speed exercise given its recent accuracy and low error rate.

Procedures

The specific design of this study was a convenience sampling of outpatient behavioral health patients within a primary care setting diagnosed with depression or experiencing at least moderate levels of depression (as measured by the PHQ-9) over a 2-month period. The purpose of the current study was to research the impact of mild aerobic exercise on cognitive symptoms of depression and will add to the body of research that has looked at treatment factors relating to depression. The current study researched the independent variable of exercise measured through steps per-day and how it interacts with the cognitive symptoms of depression through the dependent variables of attention/concentration, planning/organization, retrospective memory, and prospective memory, as well as mood/physical related symptoms of depression and life satisfaction.

Participants were recruited in person by behavioral health consultants and behavioral health interns at a local primary care health center during the winter of 2019/2020. Participants were randomized into two separate groups, the treatment and control groups. Research participants were randomly assigned a number for analytical means that in no way was associated with specific groups or individuals for a true experimental design. Contact was maintained through Qualtrics' survey platform through

an email basis with participants once they had consented to the study and the use of their email. No internet information was tracked or monitored for this study. Information gathered for this study was confidential and stored either using HIPAA-compliant computers/software (electronic information) or in a locked filing cabinet in behavioral health offices behind a locked door (paper information, such as consent/previous screeners).

Once participants consented, they filled out a standard demographic form, the PDQ-D, the PHQ-9, and the SWLS for baseline scores of cognitive symptoms of depression, mood/physical symptoms of depression, and life satisfaction. They were asked to download the free and valid pedometer app, Runtastic Steps, to track their steps per day on their smartphone device. Both groups were given information about safe and fun walking routes in the local area as well as information related to increasing steps per day in normal environments (work and home). The experimental group was asked to increase their steps per day to as close to 10,000 steps as possible. Steps will be self-reported by participants through weekly Qualtrics surveys where they input the easy-to-read information given under the activity tab of the Runtastic Steps app (Appendix E). The study ran for 2 months and the PDQ-D, the PHQ-9, and the SWLS were given at baseline, and the 2-month mark (post-test) to be measured for change from baseline scores. Behavioral health treatment as normal continued within both groups, although only the experimental group received the exercise intervention for a pretest-posttest control-group between-subjects design. Incentives were used for this research. Participants were given the option to participate in a drawing for a chance to receive one of three $50 Amazon gift cards at the conclusion of the study. Data collection began after

receiving Institutional Review Board approval for the study from Northwest University as well as approval from the local health center organization.

Analytical Strategy

After the conclusion of the study, research data was scored as appropriate per instrument and imported to IBM SPSS Statistics (SPSS) along with step data for statistical analysis. Participants were given a random number and their demographic information was numerically coded for analysis. The variables were analyzed in SPSS through descriptive statistics to understand and best summarize the present data and relationships. The independent variable of mild aerobic exercise (average steps per day) was assessed for effect in relation to the dependent variables of attention/concentration, planning/organization, retrospective memory, prospective memory, as well as mood/physical related symptoms of depression through a one-way multivariate analysis of variance (MANOVA). If significance was found, the independent variable and the dependent variables would be further assessed for effect through independent analyses to understand the individual impact of mild aerobic exercise on cognitive symptoms of the depression, mood/physical symptoms of depression, and life satisfaction, respectfully. The independent variable of mild aerobic exercise (steps per day) would be assessed for effect in cognitive symptoms of depression in relation to the dependent variables of attention/concentration, planning/organization, retrospective memory, and prospective memory through a second one-way MANOVA. The independent variable of mild aerobic exercise would also be assessed for effect in relation to the dependent variable of mood/physical related symptoms of depression through a third one-way MANOVA. The independent variable of mild aerobic exercise would be assessed for further effect in

relation to the dependent variable of life satisfaction through a one-way analysis of variance (ANOVA).

Summary

This section discussed the current research design that investigated the relationship between mild aerobic exercise and the cognitive symptoms of depression. This study is a pretest-posttest control-group between subject's true experimental design that sought to answer the hypothesis of mild aerobic exercise, as measured by steps per day, having a positive impact on cognitive symptoms of depression, specifically, attention/concentration, planning/organization, retrospective memory, prospective memory, as well as mood/physical related symptoms of depression and life satisfaction. Steps per day were measured through the free pedometer app, available on all smartphone platforms, Runtastic Steps, while cognitive symptoms of depression were measured through the PDQ-D, mood/physical symptoms of depression were measured through the PHQ-9, and life satisfaction was measured through the SWLS.

Chapter 3

Results

The present study is meant to address a gap in the literature on whether mild aerobic exercise has a positive impact on symptoms of depression. Specifically, this study was concentrated on whether mild aerobic exercise measured in steps per day would have a positive or negative impact on cognitive symptoms of depression including attention/concentration, planning/organizing, retrospective memory, and prospective memory, as well as mood/physical symptoms of depression, and satisfaction with life. This study was a pretest-posttest control-group between-subjects true experimental design that had a convenience sampling of 10 participants with a depressive disorder in a primary care medical clinic. Over 50 patients were approached to participate in the study, with 31 of these patients consenting in person for the consent form and surveys to be emailed to them via Qualtrics. Of these individuals, 14 consented to participate in the study via Qualtrics and completed the first survey measures. Of the 14 participants, 10 completed all the pre- and post-survey measures for a total of five participants in the control group and five participants in the experimental group.

Analytical Strategy

At the end of the research study items on the PDQ-D were summed for each domain per individual. Scores on the four domains of attention/concentration, planning/organization, retrospective memory, and prospective memory were summed with scores ranging from 0-20, with higher scores equaling greater perceived cognitive impairment. The scores from the PHQ-9 were summed per individual with scores ranging from 0-27, with higher scores indicating greater perceived depression severity.

The SWLS scores were summed per individual with scores ranging from 0-35. Higher scores indicated greatest believed satisfaction with life. Each measure was summed for pre and post to compare differences between groups. Steps per day were averaged per participant based on weekly emails inquiring about average steps per day tracked by the Runtastic Steps app. Once participant information from pre and post measures were summed as appropriate data was transferred into SPSS for statistical analysis. The independent variable of mild aerobic exercise was assessed for effect in relation to the dependent variables of attention/concentration, planning/organization, retrospective memory, prospective memory, as well as mood/physical related symptoms of depression, and satisfaction with life through a one-way multivariate analysis of variance (MANOVA).

Descriptive Statistics

Descriptive statistics were run in SPSS to understand relationships between the data. Between the two groups, the control group averaged 3,209 (SD = 1943.88) steps per day while the experimental group averaged 4,600 (SD = 1294.22) steps per day. A one-way analysis of variance (ANOVA) showed that while the experimental group averaged a higher number of steps than the control group, it was not a statistically significant difference $F(1, 8) = 1.77$, $p = ns$, $\eta^2 = .18$. No differences were noted between sex, although an uneven number of males to females would have the propensity to skew any significant data present. Tables 1-3 depict descriptive statistics between the control and experimental group on levels of perceived cognitive difficulty with attention/concentration, planning/organization, retrospective memory, prospective memory, physical and mood-related symptoms of depression, and satisfaction with life

scores. These descriptive statistics have been broken down into pre- and post-survey item scores with cognitive symptoms of depression in table one, mood/physical symptoms of depression in table two, and satisfaction with life in table three.

Table 1

Cognitive Symptoms of Depression

Dependent Variable	Group	Pre-Survey		Post-Survey		
		M	SD	M	SD	N
Attention/Concentration	Control	13.2	4.15	11.6	4.67	5
	Experimental	8	5.24	5.8	4.15	5
	Total	10.6	5.23	8.7	5.17	10
Planning/Organization	Control	10.4	4.10	10	4.41	5
	Experimental	9.8	6.10	8	4.78	5
	Total	10.1	4.91	9	4.78	10
Retrospective Memory	Control	12	6.89	9.8	5.63	5
	Experimental	6.2	5.07	3.8	2.95	5
	Total	9.1	6.47	6.8	5.29	10
Prospective Memory	Control	11.2	4.09	10.2	5.93	5
	Experimental	7	7.68	4.6	5.03	5
	Total	9.1	6.21	7.4	5.97	10

Table 2

Mood/Physical Symptoms of Depression

Dependent Variable	Group	Pre-Survey		Post-Survey		
		M	SD	M	SD	N
PHQ-9	Control	19.6	6.31	16.2	7.43	5
	Experimental	9.4	4.16	6.8	4.44	5
	Total	14.5	7.37	11.5	7.61	10

Table 3

Satisfaction with Life

Dependent Variable	Group	Pre-Survey		Post-Survey		
		M	SD	M	SD	N
SWLS	Control	14.4	8.74	14.8	8.93	5
	Experimental	14.8	7.19	18.8	7.46	5
	Total	14.6	7.55	16.8	8.04	10

Inferential Statistics

A one-way MANOVA was performed to understand the impact of the independent variable on the dependent variables. Using Pillai's Trace no statistically significant differences were found between the experimental groups increased mild aerobic activity compared to the control groups mild aerobic activity in terms of cognitive symptoms of depression, mood/physical symptoms of depression, and life satisfaction, $V = .79$, $F(6, 3) = 1.97$, $p = ns$, $\eta_p^2 = .79$. Due to small sample size of 10 overall participants, independent one-way ANOVAs were calculated per dependent variable for further understanding of the impact of mild aerobic exercise on the dependent variables. No statistically significant differences were found between increased levels of mild aerobic activity in the experimental group compared with the control groups mild aerobic activity on the dependent variables of attention/concentration $F(1, 8) = .21$, $p = ns$, $\eta_p^2 = .026$, planning/organization $F(1, 8) = .39$, $p = ns$, $\eta_p^2 = .047$, retrospective memory, $F(1, 8) = .012$, $p = ns$, $\eta_p^2 = .002$, prospective memory $F(1, 8) = .66$, $p = ns$, $\eta_p^2 = .076$, mood/physical symptoms of depression $F(1, 8) = .18$, $p = ns$, $\eta_p^2 =$

.023, and satisfaction with life $F(1, 8) = 5.06$, $p = ns$, $\eta_p^2 = .38$. It was noted that satisfaction with life verged on significance.

Due to the high partial eta squared effect size present in the MANOVA, additional 2x2 ANOVAs were calculated. Mixed ANOVA designs were utilized with control/experimental group as the between subjects' factor and time (pre/post survey) as the within subjects' factor, per dependent variable. These ANOVAs were utilized in order to understand the interaction effect of individual pre and post survey scores and assigned group on the dependent variables. No main interaction effects were found between group, pre/post survey scores, and attention/concentration $F(1, 8) = .022$, $p = ns$, $\eta_p^2 = .001$, planning and organization $F(1, 8) = .095$, $p = ns$, $\eta_p^2 = .006$, retrospective memory $F(1, 8) = .002$, $p = ns$, $\eta_p^2 = .00$, prospective memory $F(1, 8) = .072$, $p = ns$, $\eta_p^2 = .004$, mood and physical symptoms of depression $F(1, 8) = .024$, $p = ns$, $\eta_p^2 = .002$, and satisfaction with life $F(1, 8) = .246$, $p = ns$, $\eta_p^2 = .015$.

The different pre/post scores have been broken down by variable, and the cognitive symptoms of depression are displayed in Figures 1-4. Mood/physical related symptoms represented by PHQ-9 scores are depicted in Figure 5, while satisfaction with life represented by SWLS scores are displayed by group in Figure 6. While higher scores on PHQ-9 indicated physical/mood-related symptoms of depression present, higher scores on the SWLS indicated higher satisfaction with life.

Figure 1

Attention/Concentration

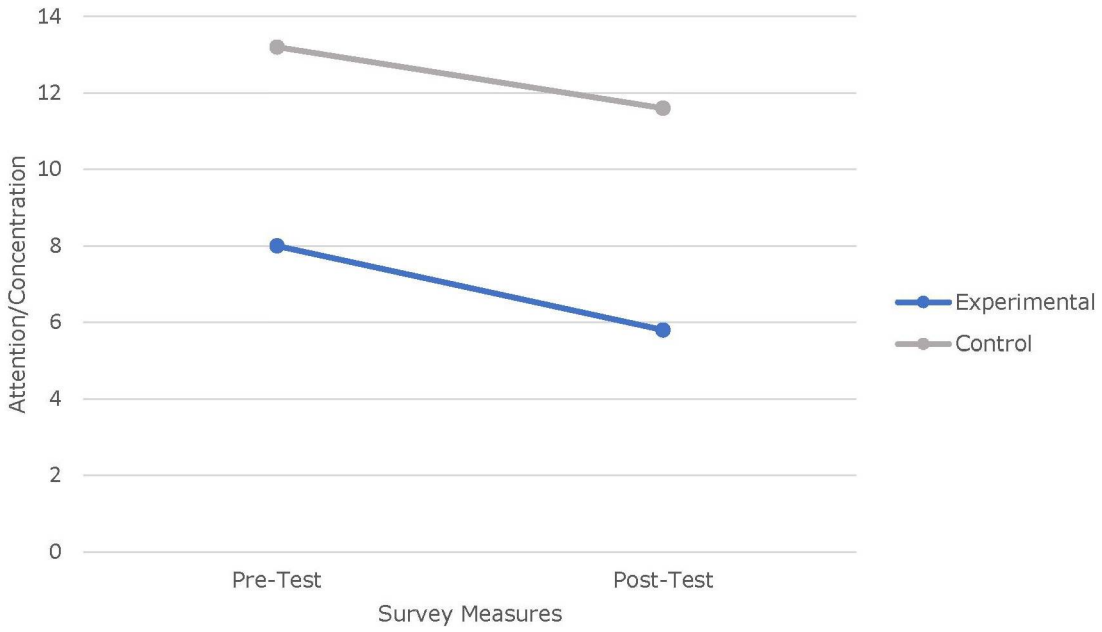


Figure 2

Panning/Organization

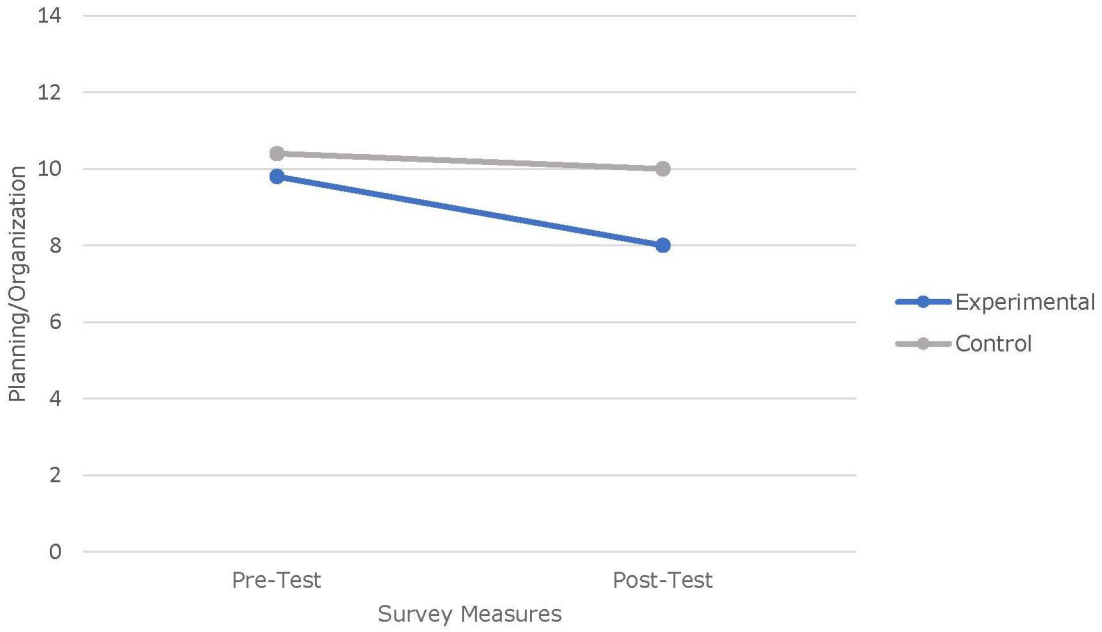


Figure 3

Retrospective Memory

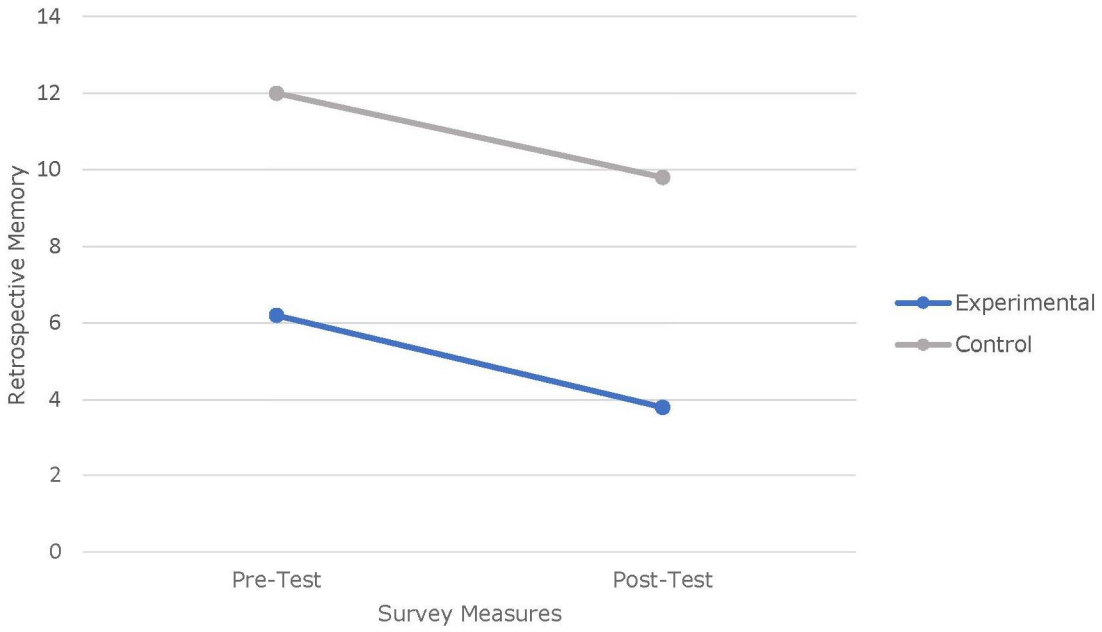


Figure 4

Prospective Memory

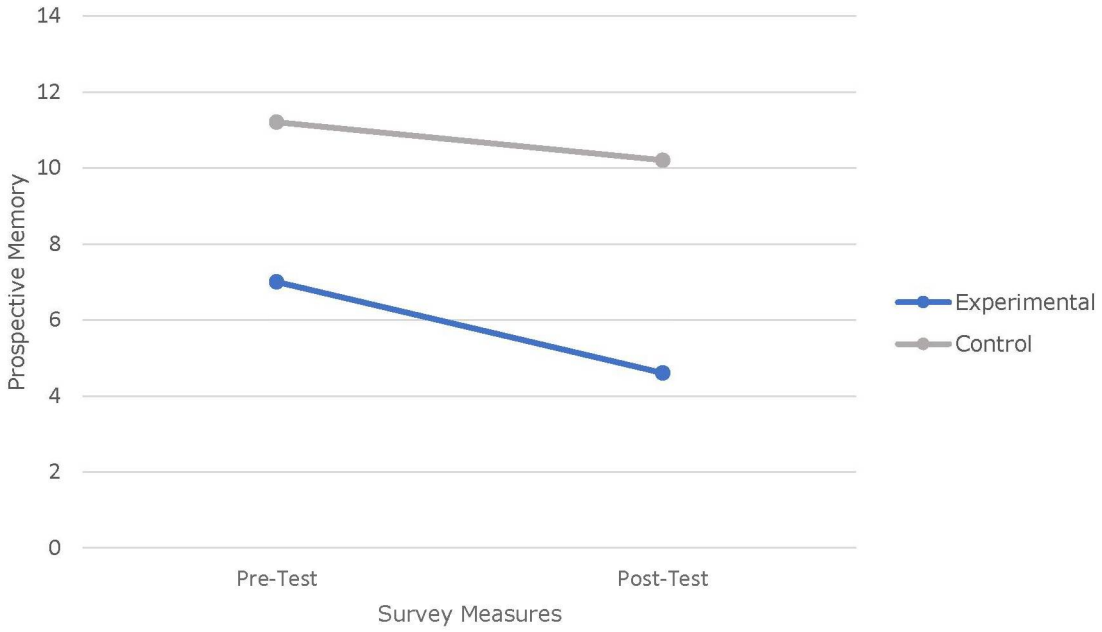


Figure 5

Mood/Physical Symptoms of Depression

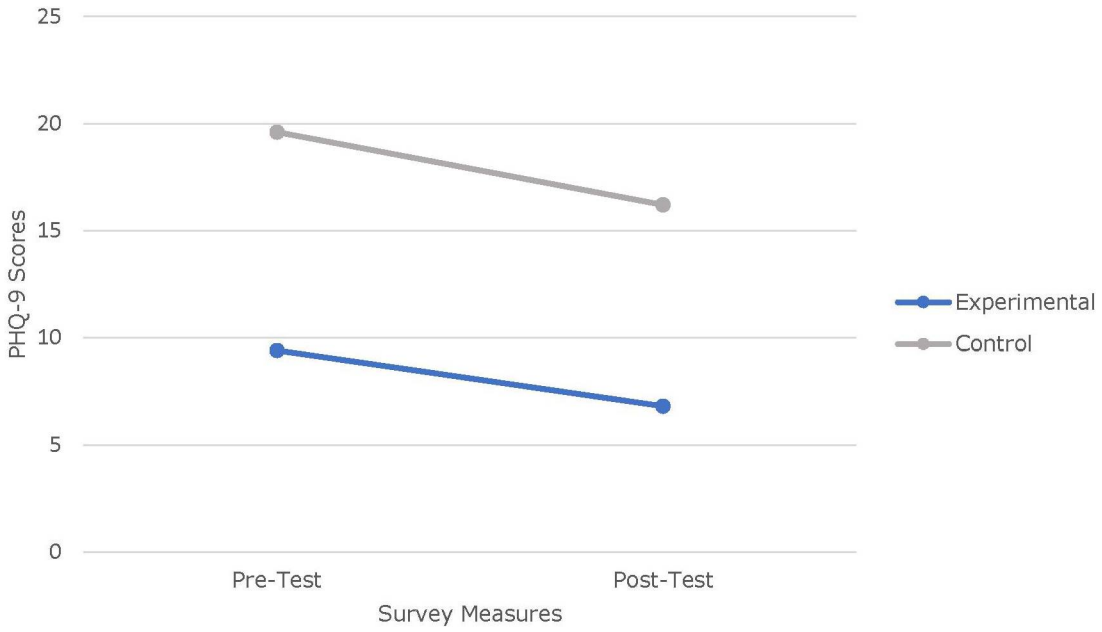


Figure 6

Satisfaction with Life

Summary

This section discussed the results of the pretest-posttest control-group between-subjects true experimental design research study that sought to understand the relationship between mild aerobic activity, cognitive symptoms of depression, mood/physical symptoms of depression, and satisfaction with life. This study was comprised of a convenience sample of 10 participants receiving behavioral health care in a primary care medical setting. In total, eight participants had a diagnosis of MDD, two with co-occurring post-traumatic stress disorder, one with co-occurring generalized anxiety disorder, and one with co-occurring panic disorder, one participant had a diagnosis of adjustment disorder with depressed mood, and one participant had co-occurring diagnoses of an unspecified depressive disorder and post-traumatic stress disorder.

Participants were randomly separated into a control and experimental group with the experimental group being asked to increase their steps per day as close to 10,000 steps as possible, while the control group was asked to monitor their steps per day. The experimental group had an increased number of steps per day compared with the control group, although a one-way ANOVA did not find this to be a statistically significant amount. No statistically significant difference was found from the one-way MANOVA used to measure the relationship between the independent variable of mild aerobic exercise (measured in average steps per day) to the dependent variables of cognitive symptoms of depression measured through attention/concentration, planning/organization, retrospective memory, prospective memory, mood/physical symptoms of depression, and satisfaction with life. Upon further review of the variables

through six one-way ANOVAs, no significant statistical differences were found. Of note, life satisfaction verged on significance and although statistical significance was not found, participants improved across measures on average with three participants in each group having noted improvement across all measures.

Chapter 4

The purpose of the present study was to answer the need for further research on interventions and treatments for the cognitive symptoms of depression, specifically regarding exercise. The findings will be discussed and interpreted concerning this purpose while exploring weaknesses and limitations within the study, as well as further directions for research.

Interpretation

The present study did not find a significant impact of mild aerobic exercise on cognitive symptoms of depression, mood/physical symptoms of depression, and life satisfaction. Increased mild aerobic exercise measured in average steps per day did not significantly interact with any of the variables. While a statistically significant result was not found, participant measures had been positively impacted by the post-survey, with the largest impact seen in PHQ-9 scores.

An aspect that may have impacted statistical significance was a gap that was noted in scores on the initial survey items, and in some cases, continued to post-survey item scores. Participants in the control group, on average, had higher scores on the PHQ-9 and PDQ-D scales. This difference indicated that, on average, participants in the control group presented with more mood/physical symptoms of depression as well as cognitive symptoms of depression than those in the experimental group. While this difference was not accounted for statistically, it may be a representation of the sample population studied. Participants utilizing the primary care behavioral health services may have had varying levels of engagement with behavioral health treatment as well as varying lengths of time that they had already been engaged in treatment. These questions were not asked

in the demographic survey although may be represented by higher, on average, symptoms scores on the PHQ-9 and the PDQ-D in the control group.

While no statistical significance was found the experimental groups' post scores on satisfaction with life increased by four points (*SD* 2.65), while the control groups increased by only four-tenths of a point (*SD* 2.41). The World Health Organization has classified satisfaction with life as an indicator of subjective wellbeing, which is one of the main elements of mental health, and depression (Gigantesco et al., 2019). Participants in the experimental group were, on average, able to increase satisfaction with life from dissatisfied levels to slightly dissatisfied levels. While satisfaction with life levels in the experimental group were not in a satisfied with life range, there still was an increase in life satisfaction, although not statistically significant, compared to the control group.

Sample Size

The results from the present study may be related to the small sample size rather than a true lack of significant impact from the variables. A power analysis was conducted before research began that indicated a sample size of at least 40 participants would be needed, at minimum, to be able to have a moderate power for statistical analysis. The present researched sample size of 10 did not reach the indicated minimum number of participants for statistical power.

While more participants than the overall 10 signed up and displayed an interest in participating in the study, motivation, and ability to complete the two-month time frame impacted overall numbers. Anhedonia, a common feature of depression, impacts an individual's ability to engage with rewarding behaviors (Sherdell et al., 2012). This

symptom may have impacted this sample population's ability to regularly track steps per day and respond to survey items.

The sample size of the present study may have also been impacted via two unforeseeable events that occurred during the duration of the study. The first event involved a ransomware virus that attacked the local primary care medical center's computer system, causing all computers to be shut down with their hard drives wiped clean. This impacted data that was used in the study and made contacting participants during this time difficult. Another unforeseeable event was the coronavirus disease 2019 (COVID-19). This virus impacted participants' ability to attend behavioral health visits at the local primary care medical center, as well as responding to and participating in the present study. Multiple participants in the present study with a diagnosis of depression also had co-occurring health disorders, that put them at a higher risk for contracting COVID-19. Due to this, they found mild aerobic activity to be difficult and limited engagement with the present dissertation study. These two events had a large impact on the healthcare system where this study took place and on the retention of participants for the duration of the study, which impacted the sample size and statistical power.

The design of the present study that utilized online survey-based measures was implemented to best utilize resources in the primary care medical center and to not take time away from behavioral health visits. Participants may have had less anhedonia and more motivation during in-person behavioral health visits. For less study attrition, and stronger motivation for participation, future research may benefit from in-person consent and survey measures.

Integration

This present study adds to the body of research that has studied the impact of exercise interventions on depression, specifically the impact of mild aerobic exercise on cognitive symptoms of depression. Brondino et al. (2017) did not find significant results within their meta-analysis in terms of aerobic exercise positively impacting cognitive symptoms of depression, although the trend was noted that mild aerobic exercise was bordering significance. The present study sought to investigate this claim, though did not have the statistical power due to a small sample size to adequately explain this trend. It was noted that there was a small reduction of self-reported cognitive symptoms of depression through the pre and post domains of the PDQ-D, although none of the reductions were statistically significant. A similar study with a larger sample size to increase statistical power may be able to further investigate the trend noticed within the Brondino et al. (2017) meta-analysis.

Hallam et al. (2018) found a significant impact on wellbeing when participants increased their steps per day, regardless of whether they hit the target 10,000 steps per day. This significant increase in wellbeing included a reduction in depression-related scores (Hallam et al., 2018). The present study's results did not find any significant impact with increased steps per day and satisfaction with life and reduction of depression-related scores. As mentioned previously, the sample size may have impacted the ability to have statistical significance, although other factors may have impacted the ability to have similar findings to the Hallam et al. (2018) study. The Hallam et al. (2018) study was conducted with a community based (non-clinical) sample of 1,963 participants over a 100-day period. Their ability to have significant findings was impacted by the

large sample size as well as the longer study period. The present dissertation study was conducted on a clinical sample of participants with depression diagnoses over a shorter, 2-month period, and specifically looked at cognitive symptoms of depression as four of the variables. Averill et al. (2018) discussed that physical activity had been noted as a biomarker with individuals experiencing symptoms of depression indicating that participants in the present study may have had the propensity for lower average steps per day than the participants in the Hallam et al. (2018) study.

Eskilsson et al. (2017) found that moderate to high levels of aerobic activity had a significant positive impact on memory problems with individuals experiencing depression, yet no significant difference in other cognitive symptoms/domains. For multiple reasons, the present study did not find similar results regarding memory compared to Eskilsson et al.'s (2017) research. The present dissertation study investigated the impact of mild aerobic activity measured through increased steps per day and did not have specific exercise trials, as it was a participant self-selected duration intervention. It had been noted previously that aerobic exercise intensities above 60% were more likely to indicate increased serotonin levels and protective factors against psychological stress (Heijnen et al., 2016; Schuch et al., 2014). The present study's exercise level intensity may not have had a similar level of impact on psychological stress, one of the indicators of depression and cognitive dysfunction in depression, which could have impacted results on cognitive symptom variables (Carneiro et al., 2017).

Differences noted between the present study and other literature in the field regarding exercise-based interventions for symptoms of depression and cognitive dysfunction in depression were present because of multiple factors. There is a lack of

research on mild aerobic interventions for cognitive symptoms of depression, in a clinical population, which this study hoped to address. The present study had a lower statistical power due to sample size than other research as well as different exercise-based interventions. These non-significant results do not imply that mild aerobic exercise would not have a positive impact on cognitive symptoms of depression overall; rather, that the present study did not have the statistical power to fully answer this important question from the sample size studied.

Exploration

The present study was an exploratory study that sought to understand the impact of mild aerobic exercise on cognitive symptoms of depression, mood/physical symptoms of depression, and life satisfaction in a clinical sample of primary care behavioral health patients. Stanton et al. (2014) discussed that many general practitioners have low levels of confidence in prescribing exercise as a treatment for depression, which makes primary care patients an important population to research. Within researching this population there are limitations. Multiple of the present study's participants had co-occurring mental health diagnoses that may have impacted symptom remission. Psychopharmacologic medications were not controlled for within this study and multiple participants were on different medications that could impact outcomes as anti-depressant medications have been noted to moderate the impact of exercise on the BDNF serum response (Goekent et al., 2011). A step to enhance future research would be to control for psychiatric medications and co-occurring disorders to understand treatment response to exercise interventions.

An important aspect of this study was that participants were also receiving care with behavioral health providers at their primary care medical clinic, as the exercise intervention was viewed as an adjunctive measure to treatment. With the specific primary care behavioral health model utilized at the healthcare organization, behavioral health visits may vary in length, frequency, as well as modality, depending on the participant. The present study did not control for the modality of the practitioner or frequency of behavioral visits that the participants received. A future step that would aid statistical power within this research field would be to recruit participants who engaged more frequently in behavioral health services (two-week follow-ups compared to one-time p/month) and collect data on the modality used in their treatment. This could be another independent variable in future research that could enhance the understanding of the efficacy of exercise interventions with this population.

The exercise intervention in the present study was self-monitored by the participant while using a smartphone application. The average steps per day were reported weekly via survey responses sent to the participant's email. Not every participant responded to the survey measures in a timely manner, which could have impacted the reporting accuracy of their average steps. The utilization of a real-time activity monitor, such as a Fitbit, would ensure the accuracy of responses if future researchers had direct access to the movement and average step data.

Direct access to step data through the utilization of a Fitbit or other activity monitoring platform would eliminate the barrier of participants having a smartphone device that could download an application to track their steps. Another barrier that could be assessed in future research would be participants' access to a working email. The

present study platform required regular access to an email to consent and answer online survey measures through the confidential survey platform Qualtrics. This platform was used to best utilize resources at the primary care medical center by not having participants fill out survey measures during behavioral health appointments, which in turn would take time away from their care. While this method allowed participants to not have time taken out of their behavioral health visits, it also led to attrition in the present study. Having pre- and post-survey measures filled out during behavioral health engagement would help control attrition rates throughout a 2 month or longer study protocol.

Future Directions

Cognitive symptoms of depression are not often considered first-line treatment targets even though they have been indicated to mediate treatment response (Lam et al., 2014). Continued research into the impact of treatments that decrease cognitive symptoms of depression is important for decreasing the societal fiscal impact of depression and depressed symptomology, and increase patient functioning. Exercise has been indicated as an intervention that has been noted to have a positive impact on cognitive functioning and on symptoms related to depression at moderate to high-level intensities (Bernstein & McNally, 2017; Hallam et al., 2018; Heijnen et al., 2016; Schuch et al., 2014; Teychenne et al., 2008). Future research into mild aerobic exercise impact on cognitive symptoms of depression with access to a large enough sample to have a significant power would be important to understand if increasing movement, or steps per day, would have a significant impact on cognitive symptoms of depression as well as overall wellbeing. Mild aerobic exercise is an important variable because it is a low barrier option for individuals to engage in aerobic activities that could have a benefit on

their overall wellbeing. Sims-Gould et al. (2017) outlined through their community-based research that an approachable form of exercise intervention would include self-selected mild-moderate aerobic activity. A study that assessed different levels of exercise in clinical populations in regard to cognitive symptoms of depression as well as overall satisfaction with life would be important to understand the significance of different levels of aerobic exercise (mild, moderate, high) and their applicability as an adjunctive treatment measure.

The present research study did not have significant statistical findings between the variables, although it was noted that symptoms scores had improved on average by post-survey measures and that satisfaction with life had increased on average in the experimental group. This may provide the implication that a larger sample size with enough statistical power may find significance if a similar research model were to be used. Satisfaction with life is an important variable to include in research with depression and cognitive dysfunction because it has been indicated by Gigantesco et al. (2019) as the main measure of subjective well-being – a strong indicator of mental health. The present study indicated that, although not at a point of statistical significance, satisfaction with life may be tied to activity level.

Conclusion

The present study was a pretest-posttest control-group between-subjects true experimental design that was meant to address a gap in the field on whether mild aerobic exercise had a significant impact on symptoms of depression. The study sought to answer the more specific question of whether mild aerobic exercise, measured in steps per day, would have a positive or negative impact on cognitive symptoms of depression including

attention/concentration, planning/organizing, retrospective memory, and prospective memory, as well as mood/physical symptoms of depression, and satisfaction with life.

This study was a convenience sample of 10 participants diagnosed with a depressive disorder who were engaging with behavioral health services in a primary care medical clinic. Five participants were randomly assigned to the control group and asked to monitor their steps per day, and five participants were randomly assigned to the experimental group and asked to increase their steps per day as close to 10,000 steps per day as possible. Steps per day were tracked through the pedometer step application Runtastic Steps, cognitive symptoms of depression were tracked through the four domains of the PDQ-D, mood/physical symptoms of depression were tracked via the PHQ-9, and satisfaction with life was tracked via the SWLS.

The study ran for two months and pre and post-test measures were collected. A one-way MANOVA was run to understand the impact between the independent variable of mild aerobic activity, measured in average steps per day, and six dependent variables of attention/concentration, planning/organization, retrospective memory, prospective memory, mood/physical symptoms of depression, and satisfaction with life. No statistical significance was found between any of the variables. While no statistical significance was found, participants, on average, had improved symptom scores on the four domains of the PDQ-D and the PHQ-9 measures. The experimental group had, on average, improvement in satisfaction with life from the dissatisfied level to the slightly dissatisfied level. The sample size was a major weakness of the study as the sample of participants did not have the statistical power necessary to find a significant interaction between the variables. Understanding the impact of mild aerobic activity on cognitive symptoms of

depression remains an important area of study to further understand beneficial interventions to help improve quality of life and alleviate suffering in patients experiencing symptoms of depression.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Author.

Angst, J., & Dobler-Mikola, A. (1985). The Zurich study. *European Archives of Psychiatry and Neurological Sciences*, *235*(3), 179-186. https://doi.org/10.1007/BF00380990

Angst, J., Hengartner, M. P., Rogers, J., Schnyder, U., Steinhausen, H. C., Ajdacic-Gross, V., & Rössler, W. (2014). Suicidality in the prospective Zurich study: Prevalence, risk factors and gender. *European Archives of Psychiatry and Clinical Neuroscience*, *264*(7), 557-565. https://doi.org/10.1007/s00406-014-0500-1

Arroll, B., Goodyear-Smith, F., Crengle, S., Gunn, J., Kerse, N., Fishman, T., Falloon, K., Hatcher, S. (2010). Validation of PHQ-2 and PHQ-9 to screen for major depression in the primary care population. *The Annals of Family Medicine*, *8*(4), 348-353. https://doi.org/10.1370/afm.1139

Averill, I. R., Crowe, M., Frampton, C. M., Beaglehole, B., Lacey, C. J., Jordan, J., Wilson, L. D., Douglas, K. M., & Porter, R. J. (2018). Clinical response to treatment in inpatients with depression correlates with changes in activity levels and psychomotor speed. *Australian & New Zealand Journal of Psychiatry*, *52*(7), 652-659. https://doi.org/10.1177/0004867417753549

Bernard, P., Romain, A. J., Caudroit, J., Chevance, G., Carayol, M., Gourlan, M., Needham Dancause, K., & Moullec, G. (2018). Cognitive behavior therapy combined with exercise for adults with chronic diseases: Systematic review and meta-analysis. *Health Psychology*, *37*(5), 433. https://doi.org/10.1037/hea0000578

Bernstein, E. E., & McNally, R. J. (2017). Acute aerobic exercise hastens emotional recovery from a subsequent stressor. *Health Psychology*, *36*(6), 560-567. https://doi.org/10.1037/hea0000482

Bijl, R. V., Ravelli, A., & Van Zessen, G. (1998). Prevalence of psychiatric disorder in the general population: results of The Netherlands Mental Health Survey and Incidence Study (NEMESIS). *Social Psychiatry and Psychiatric Epidemiology*, *33*(12), 587-595. https://doi.org/10.1007/s001270050098

Booij, L., Van der Does, A. W., Haffmans, P. J., Riedel, W. J., Fekkes, D., & Blom, M. J. (2005). The effects of high-dose and low-dose tryptophan depletion on mood and cognitive functions of remitted depressed patients. *Journal of Psychopharmacology*, *19*(3), 267-275. https://doi.org/10.1177/0269881105051538

Brondino, N., Rocchetti, M., Fusar-Poli, L., Codrons, E., Correale, L., Vandoni, M., Barbui, C., & Politi, P. (2017). A systematic review of cognitive effects of exercise in depression. *Acta Psychiatrica Scandinavica*, *135*(4), 285-295. https://doi.org/10.1111/acps.12690

Bruder, G. E., Alvarenga, J. E., Alschuler, D., Abraham, K., Keilp, J. G., Hellerstein, D. J., Steward, J. W., & McGrath, P. J. (2014). Neurocognitive predictors of antidepressant clinical response. *Journal of Affective Disorders*, *166*, 108-114. https://doi.org/10.1016/j.jad.2014.04.057

Carneiro, L. S., Mota, M. P., Vieira-Coelho, M. A., Alves, R. C., Fonseca, A. M., & Vasconcelos-Raposo, J. (2017). Monoamines and cortisol as potential mediators of the relationship between exercise and depressive symptoms. *European Archives of Psychiatry and Clinical Neuroscience*, *267*(2), 117-121. https://doi.org/10.1007/s00406-016-0719-0

Carriere, J. S., Cheyne, J. A., & Smilek, D. (2008). Everyday attention lapses and memory failures: The affective consequences of mindlessness. *Consciousness and Cognition*, *17*(3), 835-847. https://doi.org/10.1016/j.concog.2007.04.008

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., Elavsky, S., Marquez, D. X., Liang, H., & Kramer, A. F. (2006). Aerobic exercise training increases brain volume in aging humans. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *61*(11), 1166-1170. https://doi.org/10.1093/gerona/61.11.1166

Cuff, B. M., Brown, S. J., Taylor, L., & Howat, D. J. (2016). Empathy: a review of the concept. *Emotion Review*, *8*(2), 144-153. https://doi.org/10.1177/1754073914558466

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction with Life Scale. *Journal of Personality Assessment*, *49*, 71-75. https://doi.org/10.1207/s15327752jpa4901_13

Dishman, R. K., Berthoud, H. R., Booth, F. W., Cotman, C. W., Edgerton, V. R., Fleshner, M. R., Gandevia, S. C., Gomez-Pinilla, F., Greenwood, B. N., Hillman, C. H., Kramer, A. F., Levin, B. E., Moran, T. H., Russo-Neustadt, A. A., Salamone, J. D., Hoomissen, J. D., Wade, C. E., York, D. A., & Zigmond, M. J. (2006). Neurobiology of exercise. *Obesity*, *14*(3), 345-356. https://doi.org/10.1038/oby.2006.46

Docteur, A., Mirabel-Sarron, C., Guelfi, J. D., Rouillon, F., & Gorwood, P. (2013). The role of CBT in explicit memory bias in bipolar I patients. *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(3), 307-311. https://doi.org/10.1016/j.jbtep.2012.12.003

Doose, M., Ziegenbein, M., Hoos, O., Reim, D., Stengert, W., Hoffer, N., Vogel, C., Ziert, Y., & Sieberer, M. (2015). Self-selected intensity exercise in the treatment of Major depression: a pragmatic RCT. *International Journal of Psychiatry in Clinical Practice*, *19*(4), 266-275. https://doi.org/10.3109/13651501.2015.1082599

Dunn, A. L., & Dishman, R. K. (1991). Exercise and the neurobiology of depression. *Exercise and Sport Sciences Reviews*, *19*(1), 41-98.

Edman, J. L., Lynch, W. C., & Yates, A. (2014). The impact of exercise performance dissatisfaction and physical exercise on symptoms of depression among college students: A gender comparison. *The Journal of Psychology*, *148*(1), 23-35. https://doi.org/10.1080/00223980.2012.737871

Elliott, R. (1998). The neuropsychological profile in unipolar depression. *Trends in Cognitive Sciences*, *2*(11), 447-454. https://doi.org/10.1016/S1364-6613(98)01235-2

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., Kim, J. S., Susie, H., Alves, H., White, S. M., Wojcicki, T. R., Mailey, E., Vieira, V. J., Martin, S. A., Pence, B. D., Woods, J. A., McAuley, E., & Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. *Proceedings of the National Academy of Sciences*, *108*(7), 3017-3022. https://doi.org/10.1073/pnas.1015950108

Eskilsson, T., Järvholm, L. S., Gavelin, H. M., Neely, A. S., & Boraxbekk, C. J. (2017). Aerobic training for improved memory in patients with stress-related exhaustion: A randomized controlled trial. *BMC Psychiatry*, *17*(1), 322. https://doi.org/10.1186/s12888-017-1457-1

Fehnel, S. E., Forsyth, B. H., DiBenedetti, D. B., Danchenko, N., François, C., & Brevig, T. (2016). Patient-centered assessment of cognitive symptoms of depression. *CNS Spectrums*, *21*(1), 43-52. https://doi.org/10.1017/S1092852913000643

Forman, E. M., Herbert, J. D., Moitra, E., Yeomans, P. D., & Geller, P. A. (2007). A randomized controlled effectiveness trial of acceptance and commitment therapy and cognitive therapy for anxiety and depression. *Behavior Modification*, *31*(6), 772-799. https://doi.org/10.1177/0145445507302202

Gigantesco, A., Fagnani, C., Toccaceli, V., Stazi, M. A., Lucidi, F., Violani, C., & Picardi, A. (2019). The relationship between satisfaction with life and depression symptoms by gender. *Frontiers in Psychiatry*, *10*, 419. https://doi.org/10.3389/fpsyt.2019.00419

Goekint, M., Roelands, B., Heyman, E., Njemini, R., & Meeusen, R. (2011). Influence of citalopram and environmental temperature on exercise-induced changes in BDNF. *Neuroscience Letters*, *494*(2), 150-154. https://doi.org/10.1016/j.neulet.2011.03.001

Greer, T. L., Trombello, J. M., Rethorst, C. D., Carmody, T. J., Jha, M. K., Liao, A., Grannemann, B. D., Chambliss, H. O., Church, T. S., & Trivedi, M. H. (2016). Improvements in psychosocial functioning and health-related quality of life following exercise augmentation in patients with treatment response but nonremitted major depressive disorder: Results from the tread study. *Depression and Anxiety*, *33*(9), 870-881. https://doi.org/10.1002/da.22521

Hallam, K. T., Bilsborough, S., & de Courten, M. (2018). "Happy feet": Evaluating the benefits of a 100-day 10,000 step challenge on mental health and wellbeing. *BMC Psychiatry*, *18*(1), 19. https://doi.org/10.1186/s12888-018-1609-y

Heissel, A., Vesterling, A., White, S. A., Kallies, G., Behr, D., Arafat, A. M., Resischies, F. M., Heinzel, S., & Budde, H. (2015). Feasibility of an exercise program for older depressive inpatients. *GeroPsych*, *28*(4), 163-171. https://doi.org/10.1024/1662-9647/a000134

Heijnen, S., Hommel, B., Kibele, A., & Colzato, L. S. (2016). Neuromodulation of aerobic exercise—a review. *Frontiers in Psychology*, *6*, 1890. https://doi.org/10.3389/fpsyg.2015.01890

Jenkins, T., Nguyen, J., Polglaze, K., & Bertrand, P. (2016). Influence of tryptophan and serotonin on mood and cognition with a possible role of the gut-brain axis. *Nutrients*, *8*(1), 56. https://doi.org/10.3390/nu8010056

Kazdin, A. E. (2008). Evidence-based treatment and practice: new opportunities to bridge clinical research and practice, enhance the knowledge base, and improve patient care. *American Psychologist*, *63*(3), 146-159. https://doi.org/10.1037/0003-066X.63.3.146

Krämer, L. V., Helmes, A. W., Seelig, H., Fuchs, R., & Bengel, J. (2014). Correlates of reduced exercise behaviour in depression: the role of motivational and volitional deficits. *Psychology & Health*, *29*(10), 1206-1225. https://doi.org/10.1080/08870446.2014.918978

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, *16*(9), 606-613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Lam, R. W., Kennedy, S. H., McIntyre, R. S., & Khullar, A. (2014). Cognitive dysfunction in major depressive disorder: effects on psychosocial functioning and implications for treatment. *The Canadian Journal of Psychiatry*, *59*(12), 649-654. https://doi.org/10.1177/070674371405901206

Lam, R. W., Lamy, F. X., Danchenko, N., Yarlas, A., White, M. K., Rive, B., & Saragoussi, D. (2018). Psychometric validation of the Perceived Deficits Questionnaire-Depression (PDQ-D) instrument in US and UK respondents with major depressive disorder. *Neuropsychiatric Disease and Treatment*, *14*, 2861. https://doi.org/10.2147/NDT.S175188

Lenze, E. J., Mulsant, B. H., Blumberger, D. M., Karp, J. F., Newcomer, J. W., Anderson, S. J., Dew, M. A.m Butters, M. A., Stack, J. A., Begley, A. E., & Reynolds, C. F., III. (2015). Efficacy, safety, and tolerability of augmentation pharmacotherapy with aripiprazole for treatment-resistant depression in late life: a randomised, double-blind, placebo-controlled trial. *The Lancet*, *386*(10011), 2404-2412. https://doi.org/10.1016/S0140-6736(15)00308-6

Mata, J., Hogan, C. L., Joormann, J., Waugh, C. E., & Gotlib, I. H. (2013). Acute exercise attenuates negative affect following repeated sad mood inductions in persons who have recovered from depression. *Journal of Abnormal Psychology*, *122*(1), 45-50. https://doi.org/10.1037/a0029881

Magovern, M. K., & DeGeorge, K. C. (2015). Vortioxetine (brintellix) for the treatment of depression. *American Family Physician*, *91*(5), 325-326.

Margison, F. R., Barkham, M., Evans, C., McGrath, G., Clark, J. M., Audin, K., & Connell, J. (2000). Measurement and psychotherapy: Evidence-based practice and practice-based evidence. *The British Journal of Psychiatry*, *177*(2), 123-130. https://doi.org/10.1192/bjp.177.2.123

Martiny, K., Refsgaard, E., Lund, V., Lunde, M., Thougaard, B., Lindberg, L., & Bech, P. (2015). Maintained superiority of chronotherapeutics vs. exercise in a 20-week randomized follow-up trial in major depression. *Acta Psychiatrica Scandinavica*, *131*(6), 446-457. https://doi.org/10.1111/acps.12402

McConnell, M. V., Shcherbina, A., Pavlovic, A., Homburger, J. R., Goldfeder, R. L., Waggot, D., Cho, M. K., Resenberger, M. E., Haskell, W. L., Myers, J., Champagne, M. A., Mignot, E., Landray, M., Tarassenko, L., Harrington, R. A., Yeung, A. C., Ashley, E. A. (2017). Feasibility of obtaining measures of lifestyle from a smartphone app: The MyHeart counts cardiovascular health study. *JAMA Cardiology*, *2*(1), 67-76. https://doi.org10.1001/jamacardio.2016.4395

McIntyre, R. S., Lophaven, S., & Olsen, C. K. (2014). A randomized, double-blind, placebo-controlled study of vortioxetine on cognitive function in depressed adults. *International Journal of Neuropsychopharmacology*, *17*(10), 1557-1567. https://doi.org/10.1017/S1461145714000546

McIntyre, R. S., Harrison, J., Loft, H., Jacobson, W., & Olsen, C. K. (2016). The effects of vortioxetine on cognitive function in patients with major depressive disorder: a meta-analysis of three randomized controlled trials. *International Journal of Neuropsychopharmacology*, *19*(10), pyw055. https://doi.org/10.1093/ijnp/pyw055

Oertel-Knöchel, V., Mehler, P., Thiel, C., Steinbrecher, K., Malchow, B., Tesky, V., Ademmer, K., Prvulovic, D., Banzer, W., Zopf, Y., Shmitt, A., & Hansel, F. (2014). Effects of aerobic exercise on cognitive performance and individual psychopathology in depressive and schizophrenia patients. *European Archives of Psychiatry and Clinical Neuroscience*, *264*(7), 589-604. https://doi.org/10.1007/s00406-014-0485-9

Orr, K., Howe, H. S., Omran, J., Smith, K. A., Palmateer, T. M., Ma, A. E., & Faulkner, G. (2015). Validity of smartphone pedometer applications. *BMC Research Notes*, *8*(1), 733. https://doi.org/10.1186/s13104-015-1705-8

Patel, H., Alkhawam, H., Madanieh, R., Shah, N., Kosmas, C. E., & Vittorio, T. J. (2017). Aerobic *vs* anaerobic exercise training effects on the cardiovascular system. *World Journal of Cardiology*, *9*(2), 134–138. https://doi.org/10.4330/wjc.v9.i2.134

Pavot, W. G., Diener, E., Colvin, C. R., & Sandvik, E. (1991). Further validation of the Satisfaction with Life Scale: Evidence for the cross-method convergence of well-being measures. *Journal of Personality Assessment*, *57*, 149-161. https://doi.org/10.1207/s15327752jpa5701_17

Pavot, W. G., & Diener, E. (1993). Review of the Satisfaction with Life Scale. *Psychological Assessment*, *5*, 164-172. https://doi.org/10.1007/978-90-481-2354-4_5

Pearce, E. F., & Murphy, J. A. (2014). Vortioxetine for the treatment of depression. *Annals of Pharmacotherapy*, *48*(6), 758-765. https://doi.org/10.1177/1060028014528305

Pimontel, M. A., Culang-Reinlieb, M. E., Morimoto, S. S., & Sneed, J. R. (2012). Executive dysfunction and treatment response in late-life depression. *International Journal of Geriatric Psychiatry*, *27*(9), 893-899. https://doi.org/10.1002/gps.2808

Presset, B., Laurenczy, B., Malatesta, D., & Barral, J. (2018). Accuracy of a smartphone pedometer application according to different speeds and mobile phone locations in a laboratory context. *Journal of Exercise Science & Fitness*, *16*(2), 43-48. https://doi.org/10.1016/j.jesf.2018.05.001

Puterman, E., Lin, J., Blackburn, E., O'Donovan, A., Adler, N., & Epel, E. (2010). The power of exercise: buffering the effect of chronic stress on telomere length. *PloS One*, *5*(5), e10837. https://doi.org/10.1371/journal.pone.0010837

Riepe, M. W., Gritzmann, P., & Brieden, A. (2017). Preferences of psychiatric practitioners for core symptoms of major depressive disorder: a hidden conjoint analysis. *International Journal of Methods in Psychiatric Research*, *26*(1), e1528. https://doi.org/10.1002/mpr.1528

Shilyansky, C., Williams, L. M., Gyurak, A., Harris, A., Usherwood, T., & Etkin, A. (2016). Effect of antidepressant treatment on cognitive impairments associated with depression: a randomized longitudinal study. *The Lancet Psychiatry*, *3*(5), 425-435. https://doi.org/10.1016/S2215-0366(16)00012-2

Schmitt, A., & Falkai, P. (2014). Suicide ideation, stability of symptoms and effects of aerobic exercise in major depression. *European Archives of Psychiatry and Clinical Neuroscience*, 264, 555-556. https://doi.org/10.1007/s00406-014-0526-4

Schuch, F. B., Vasconcelos-Moreno, M. P., Borowsky, C., Zimmermann, A. B., Wollenhaupt-Aguiar, B., Ferrari, P., & de Almeida Fleck, M. P. (2014). The effects of exercise on oxidative stress (TBARS) and BDNF in severely depressed inpatients. *European Archives of Psychiatry and Clinical Neuroscience*, *264*(7), 605-613. https://doi.org/10.1007/s00406-014-0489-5

Schuch, F. B., Vancampfort, D., Rosenbaum, S., Richards, J., Ward, P. B., Veronese, N., Solmi, M., Cadore, E. L., & Stubbs, B. (2016). Exercise for depression in older adults: a meta-analysis of randomized controlled trials adjusting for publication bias. *Revista Brasileira de Psiquiatria*, *38*(3), 247-254. http://dx.doi.org/10.1590/1516-4446-2016-1915

Sherdell, L., Waugh, C. E., & Gotlib, I. H. (2012). Anticipatory pleasure predicts motivation for reward in major depression. *Journal of Abnormal Psychology*, *121*(1), 51. https://doi.org/10.1037/a0024945

Sims-Gould, J., Vazirian, S., Li, N., Remick, R., & Khan, K. (2017). Jump step-a community based participatory approach to physical activity & mental wellness. *BMC Psychiatry*, *17*(1), 319. https://doi.org/10.1186/s12888-017-1476-y

Smith-Marek, E. N., Durtschi, J., Brown, C., & Dharnidharka, P. (2016). Exercise and diet as potential moderators between trauma, posttraumatic stress, depression, and relationship quality among emerging adults. *The American Journal of Family Therapy*, *44*(2), 53-66. https://doi.org/10.1080/01926187.2016.1145080

Solbakken, O. A., & Abbass, A. (2015). Intensive short-term dynamic residential treatment program for patients with treatment-resistant disorders. *Journal of Affective Disorders*, *181*, 67-77. https://doi.org/10.1016/j.jad.2015.04.003

Srisurapanont, M., Suttajit, S., Eurviriyanukul, K., & Varnado, P. (2017). Discrepancy between objective and subjective cognition in adults with major depressive disorder. *Scientific reports*, *7*(1), 3901. https://doi.org/10.1038/s41598-017-04353-w

Stahl, S. M. (2017). *Stahl's essential psychopharmacology: Prescriber's guide* (6th ed.). Cambridge University Press.

Stanton, R., Franck, C., Reaburn, P., & Happell, B. (2015). A pilot study of the views of general practitioners regarding exercise for the treatment of depression. *Perspectives in Psychiatric Care*, *51*(4), 253-259. https://doi.org/10.1111/ppc.12088

Stubbs, B., Koyanagi, A., Schuch, F. B., Firth, J., Rosenbaum, S., Veronese, N., Solmi, M., Mugisha, J., & Vancampfort, D. (2016). Physical activity and depression: a large cross-sectional, population-based study across 36 low-and middle-income countries. *Acta Psychiatrica Scandinavica*, *134*(6), 546-556. https://doi.org/10.1111/acps.12654

Sullivan, M. J. L., Edgley, K., & Dehoux, E. (1990). A survey of multiple sclerosis. Part 1: Perceived cognitive problems and compensatory strategy use. *Canadian Journal of Rehabilitation*, 4, 99-105

Teicher, M. H. (1995) Actigraphy and motion analysis: New tools for psychiatry. *Harvard Review of Psychiatry*, *3*, 18–35. 10.3109/10673229509017161

Teychenne, M., Ball, K., & Salmon, J. (2008). Physical activity and likelihood of depression in adults: a review. *Preventive Medicine*, *46*(5), 397-411. https://doi.org/10.1016/j.ypmed.2008.01.009

Treacy, D., Hassett, L., Schurr, K., Chagpar, S., Paul, S. S., & Sherrington, C. (2017). Validity of different activity monitors to count steps in an inpatient rehabilitation setting. *Physical Therapy*, *97*(5), 581-588. https://doi.org/10.1093/ptj/pzx010

Wachtel, P. L. (2017). Attachment theory and clinical practice: A cyclical psychodynamic vantage point. *Psychoanalytic Inquiry*, *37*(5), 332-342. https://doi.org/10.1080/07351690.2017.1322431

Williams, C. L., & Tappen, R. M. (2008). Exercise training for depressed older adults with Alzheimer's disease. *Aging and Mental Health*, *12*(1), 72-80. https://doi.org/10.1080/13607860701529932

World Health Organization. (2017). *Depression and other common mental disorders: Global health estimates*. https://www.who.int/mental_health/management/depression/prevalence_global_health_estimates/en/

Young, S. N. (2007). How to increase serotonin in the human brain without drugs. *Journal of Psychiatry & Neuroscience: JPN*, *32*(6), 394-399.

Zimmer, P., Stritt, C., Bloch, W., Schmidt, F. P., Hübner, S. T., Binnebößel, S., Schenk, A., & Oberste, M. (2016). The effects of different aerobic exercise intensities on serum serotonin concentrations and their association with Stroop task performance: a randomized controlled trial. *European Journal of Applied Physiology*, *116*(10), 2025-2034. https://doi.org/10.1007/s00421-016-3456-1

Appendix A

Demographic Information Form

Instructions: Please provide a response for each of the following questions:

1. What is your age? _____
2. What is your Sex?
   a. Female b. Male
3. What is your marital status?
   a. Single b. Married c. Divorced d. Widowed
4. With what denomination or faith tradition do you identify?

   _____
5. With what racial or ethnic category do you identify?
   a. African American b. Asian/Pacific Islander c. Middle Eastern
   d. Latino e. White/Caucasian f. Other: _____
6. How often do you engage in aerobic exercise (walking/running) per week?
   a. None b. 1-2 times c. 3-4 times d. 5-6 times e. 7+ times
7. How often do you engage in anaerobic (weightlifting) exercise per week?
   a. None b. 1-2 times c. 3-4 times d. 5-6 times e. 7+ times
8. What is your perceived activity level?
   a. Low b. Mild c. Moderate d. Moderately High e. High
9. What are your average steps per day?
   a. < 1,000 b. 1,000-3,000 c. 3,000-4000 d. 4,000-7,000 e. > 7,000

Appendix B

Perceived Deficits Questionnaire – Depression (PDQ-D)

The following questions describe problems people may have with their memory, attention or concentration. Please select the best response based on your experiences during the past 7 days.

During the past 7 days, how often did you….		Never in the past 7 days	Rarely (once or twice)	Sometimes (3 to 5 times)	Often (about once a day)	Very often (more than once a day)
1.	Lose your train of thought when speaking?	□	□	□	□	□
2.	Have difficulty remembering the names of people, even ones you have met several times?	□	□	□	□	□
3.	Forget what you came into the room for?	□	□	□	□	□
4.	Have trouble getting things organized?	□	□	□	□	□
5.	Have trouble concentrating on what people are saying during a conversation?	□	□	□	□	□
6.	Forget if you had already done something?	□	□	□	□	□
7.	Forget appointments and meetings you had scheduled?	□	□	□	□	□
8.	Have difficulty planning what to do in the day?	□	□	□	□	□
9.	Have trouble concentrating on what you were reading?	□	□	□	□	□
10.	Forget things you did during the past 24 hours?	□	□	□	□	□
11.	Forget the date unless you looked it up?	□	□	□	□	□
12.	Have trouble getting started, even if you had a lot of things to do?	□	□	□	□	□
13.	Find your mind drifting?	□	□	□	□	□

During the <u>past 7 days</u>, how often did you….		Never in the past 7 days	Rarely (once or twice)	Sometimes (3 to 5 times)	Often (about once a day)	Very often (more than once a day)
14.	Forget what you talked about after a telephone conversation?	□	□	□	□	□
15.	Forget to do routine things like lock the door, turn off the stove, or turn on your alarm clock?	□	□	□	□	□
16.	Feel like your mind went totally blank?	□	□	□	□	□
17.	Have trouble remembering numbers even for a few seconds?	□	□	□	□	□
18.	Forget things you did 2 or 3 days ago?	□	□	□	□	□
19.	Forget to take your medication?	□	□	□	□	□
20.	Have trouble making decisions?	□	□	□	□	□

Appendix C

Patient Health Questionnaire- 9 Item (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems? *(Please circle your answer)*	**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 in some way	0	1	2	3

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**
☐	☐	☐	☐

Appendix D

SATISFACTION WITH LIFE SCALE

Scale:

Instructions: Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

____ In most ways my life is close to my ideal.

____ The conditions of my life are excellent.

____ I am satisfied with my life.

____ So far I have gotten the important things I want in life.

____ If I could live my life over, I would change almost nothing.

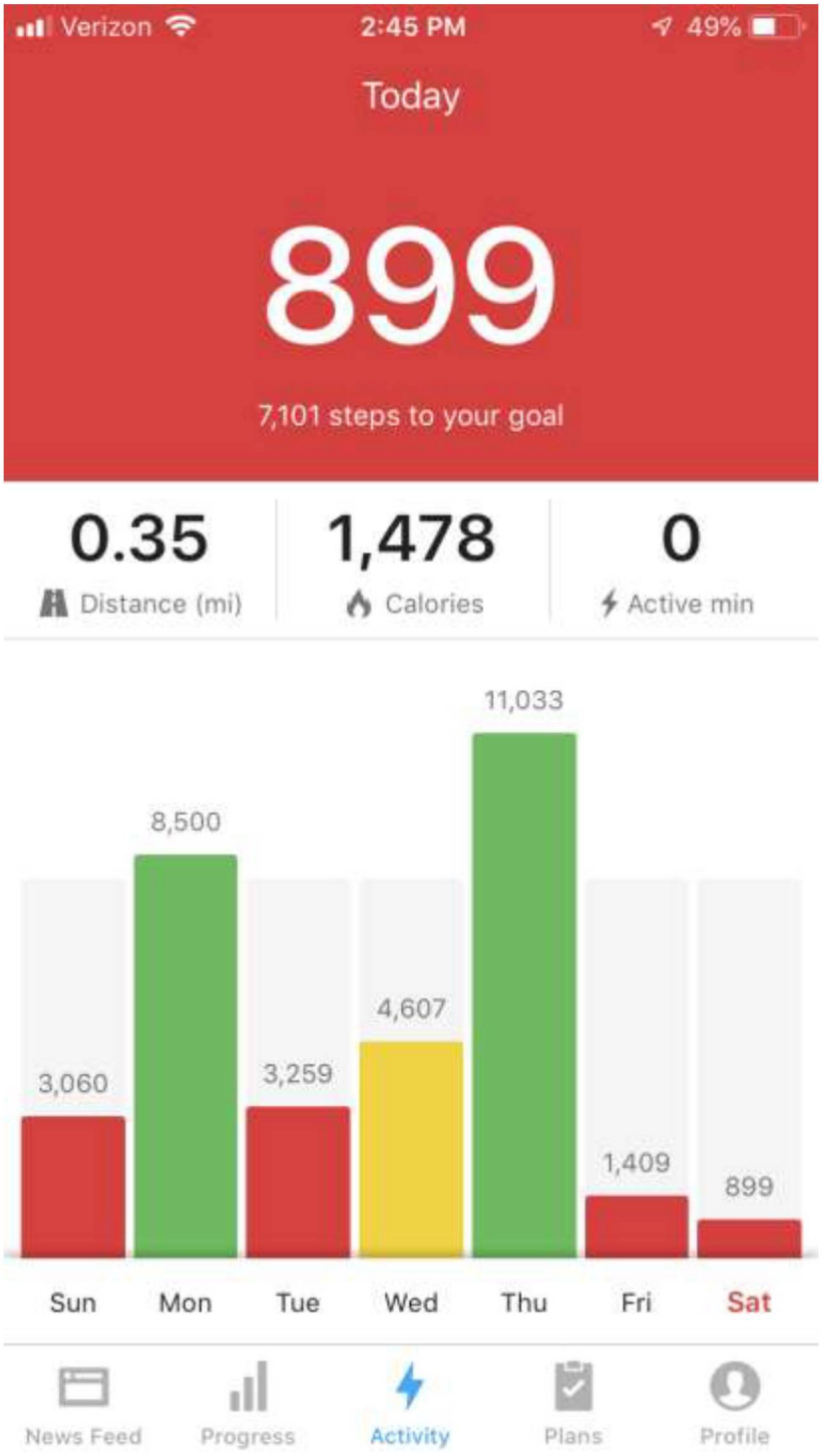
Scoring:

Though scoring should be kept continuous (sum up scores on each item), here are some cut-offs to be used as benchmarks.

- 31 - 35 Extremely satisfied
- 26 - 30 Satisfied
- 21 - 25 Slightly satisfied
- 20 Neutral
- 15 - 19 Slightly dissatisfied
- 10 - 14 Dissatisfied
- 5 - 9 Extremely dissatisfied

Appendix E

Example of Activity Tab (Runtastic Steps, 2019)



Appendix D

Mild Aerobic Exercise Impact on Cognitive Symptoms of Depression

Consent Form

Dissertation Research | Northwest University

Caleb G. Nixon

You are invited to take part in a research study. This study is run by a doctoral student at NorthwestUniversity. The study is part of a dissertation to fulfill the requirements for a Psy.D. in Counseling Psychology. The study will focus on exercise as an intervention and treatment for depression. If you agree to take part in the study, you will be asked to complete four surveys:

- Demographic survey: A survey used to get to know you. This survey asked about age, sex, culture, and exercise history.
- PDQ-D survey: A 20-question survey that asks about attention, memory, and concentration.
- PHQ-9 survey: A 9-question survey that asked about mood, energy, sleep, and feelings.
- SWLS survey: A 5-question survey that asked about satisfaction with life.

You will also be asked to download the free Runtastic Steps application(app). This app tracks your steps from your smart phone (similar to a Fitbit). It is free, simple to use, and accurate. The survey items will take less than 30 minutes to complete. Surveys will be given at the start and end of the study. You will also be asked to track your steps daily using the Runtastic Steps app. You will also report your average steps per day weekly by email. These emails will be sent out on Fridays.

There is low risk related with taking part in the study. Some people may be ill at ease answering personal questions. You may choose not to take part in this research study. The benefit of taking part in this study is taking part as a research subject. You will also practice health behaviors with a focus on your wellbeing.

Taking part in this study is completely voluntary. You may choose not to take part in this study. You may stop at any time and for any reason. There will be no penalties if you choose not to take part. You may refuse to answer any questions asked. All answers are private. No personal identifying information will be asked. You have a chance to be entered into a drawing for a $50 amazon gift card. This will be on the next page. Taking part will not impact your chances to be entered into the drawing. You may print this consent form for your records.

By completing this survey, you are giving permission to use your answers in this research study. All information will be destroyed 5 years from the conclusion of the study. The results from this study will be presented in a dissertation defense, at professional conferences, and will be published.

If you have felt any distress from this study or from information revealed, please call the 211-crisis hotline. You may also call the Crisis Connections 24-hour hotline (866-427-4747).

If you have any questions about this study, contact Caleb Nixon at Caleb.nixon15@northwestu.edu. If you have further questions, please contact my Dissertation Chair Dr. Kim Lampson at kim.lampson@northwestu.edu or 425-889-5294. You may also contact the Chair of the Northwest University IRB, Dr. Molly Quick, at molly.quick@northwestu.edu or 425-889-5327.

Thank you for your consideration of this request.

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Please print a copy of this consent form for future reference

If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" button to begin the survey

I Agree | I Do Not Agree