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Pepperdine University  
Graduate School of Education and Psychology

THE IMPACT OF EXERCISE ON ADOLESCENTS WITH DEPRESSION:  
A SYSTEMATIC REVIEW OF THE LITERATURE

A clinical dissertation submitted in partial satisfaction  
of the requirements for the degree of  
Doctor of Psychology

by

Matthew P. Kloeris

August, 2021

Erlanger Turner, Ph.D. – Dissertation Chairperson

This clinical dissertation, written by

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under the guidance of a Faculty Committee and approved by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF PSYCHOLOGY

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## VITA

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Kloeris, M., & Birath, J. (2021). *Case report: Neuropsychological assessment of giant axonal neuropathy in adulthood*. APA Convention 2021, Virtual Event.Kloeris, M., & Birath, J. (2020). *Case report: Neuropsychological assessment of giant axonal neuropathy in adulthood*. Fortieth Annual Conference of the National Academy of Neuropsychology, Virtual Event.Levernier, J., Kloeris, M., Magid, A., & O'Sullivan, M. (2010). *Upon my soul, a wicked lie: Emotional reactions to lying*. Ninetieth Annual Convention of the Western Psychological Association, Cancun, Mexico.



## ABSTRACT

The purpose of the present study was to summarize and synthesize the research that pertains to the impact of aerobic exercise on adolescents with depression. This review addressed aerobic exercise as a mental health treatment, such as differences between (a) post-intervention and follow-up response and remission rates; (b) exercise in lieu of psychotherapy or exercise as an adjunct to psychotherapy; and (c) response and remission rates amongst minority gender and racial and ethnic groups. The search results produced a total of 2,122 articles. Of which, eight articles were eligible for the present systematic review. Based on the results, it appears that aerobic exercise is effective for adolescents with depression. More specifically, aerobic exercise can be incorporated in the short- and long-term for depression. Aerobic exercise can also be used as an adjunct to psychotherapy. There are some delayed effects for aerobic exercise in lieu of psychotherapy. Lastly, it remains unclear if aerobic exercise has variable effects between genders and races/ethnicities.

## Chapter 1: The Problem

Adolescent mental health was once conceived as a time of “profound inner turmoil and outward conflict - a time of ‘storm and stress’” (Powers et al., 1989, p. 200). Psychologists, media, and the public alike assumed adolescence goes hand-in-hand with, at the very least, mild signs and/or symptoms of mental illness - to the extent that it would be abnormal for an adolescent to not have serious mental illness. It was anticipated for adolescents to be frequently moody (i.e., depressed one day and then extremely excited the following day) and conflictual with friends, families, and figures of authority. But where did this understanding of adolescence arise from?

This theory of adolescence, also known as the storm and stress theory, was largely based on observations from the psychiatric clinical community in the 1950s and early-1960s (Blos, 1962; Erikson, 1959, 1968; Freud, 1946, 1958). Clinicians and theorists opined that adolescence was a time of severe interpersonal stress. There were major tasks required for this period of time in their lives. For example, adolescents begin to develop an adult identity and separate from the family, thereby reduce psychological dependence on the parents (Erikson, 1959, 1968). As such, the adolescent psychiatric patients’ emotional crises and conflicts with authority figures were seen as normal (Blos, 1962). So much so, the emotional turmoil was conceived as inevitable and necessary for normal integration of the developing personality (Powers et al., 1989).

Research commenced in the mid-1960s in order to verify the storm and stress theory. As studies and analyses were conducted, the research consistently indicated a different perspective on adolescent mental health. The research refuted the idea that adolescents must have extreme emotional distress and turmoil. Although it was agreed that adolescence do indeed have significant tasks in this stage of their development, the literature suggested it is not always

concurrent with severe emotional stress. In fact, the research suggested that the rate of emotional disturbance for adolescents is nearly the same as adults (Offer et al., 1981; Petersen, 1988).

Consequently, a new understanding of adolescent mental health was needed. The conception of adolescence transitioned from the storm and stress theory to an interaction of biological, social, and psychological variables, also known as the biopsychosocial model (Engel, 1977; Powers et al., 1989). Consequently, clinicians have incorporated the biopsychosocial model in order to explain the appearance, development, and treatment of mental disorders, one of which is depression (Bernaras et al., 2019).

### **Depression in Adolescence**

The World Health Organization (2019) stated that “globally, depression is one of the leading causes of illness and disability among adolescents” (para. 4). In the United States, it was estimated that 3.2 million adolescents (i.e., 13.3% of the adolescent population) had one major depressive episode (National Institute of Mental Health [NIMH], 2019). But this is not the same amongst gender and minority racial/ethnic groups. In fact, the prevalence rates vary. For instance, the occurrence of depression is greater in females than males (Cyranowski et al., 2000). Although the underlying mechanisms are unclear (Albert, 2015), the research indicates that biological factors (e.g., ovarian hormone levels during puberty) may be a significant contributing factor to the gender discrepancy (Albert, 2015). Depressive symptoms in adolescent males and females differ too. Whereas males tend to exhibit behaviors such as restlessness, irritability, and difficulty in concentrating, females report guilt, worthlessness, sadness, and fatigue (Khesht-Masjedi et al., 2017). With regards to minority racial/ethnic groups, depression is highest for adolescents who identify with two or more races (NIMH, 2019). They are also less likely to receive treatment for their depression when compared to white adolescents (Cummings & Druss,

2011; Cummings et al., 2014). Several reasons exist for these disparities, some of which include, but are not limited to poverty, societal and institutional racism, and stigma regarding mental health (Holm-Hansen, 2006).

Adolescents with depression experience impairments in their academic, social, and physical functioning (Jaycox et al., 2009). Adolescents with depression reported that their feelings of sadness affected their ability to perform well in school, such as concentrating and completing homework (Humensky et al., 2010). They also indicated regular bouts of negative thinking, which led to procrastination and eventually poor performance in school (Humensky et al., 2010). Neurocognitively, there is research suggesting that adolescents with depression, particularly in the acute state of depression, experience deficits in sustained attention (Cataldo et al., 2005; Wilkinson & Goodyear, 2006), delayed verbal and nonverbal memory (Brooks et al., 2010), and executive functioning (Maalouf et al., 2011). There is research suggesting that social roles are also impacted by depression in adolescence. For example, Fergusson and Woodward (2002) found adolescents with depression may be at an increased risk of prolonged periods of unemployment and becoming a parent later in life. Lastly, given that anhedonia is a cardinal feature of depression, adolescents may be at an increased risk of reducing or eliminating physical activity that they once found enjoyable (Jerstad et al., 2010). Given the prevalence and impairments of depression in adolescence, a discussion of the biopsychosocial factors may help explain how these variables contribute to the development and maintenance of this specific disorder.

### ***Biological Variables***

Adolescents undergo rapid physical changes during adolescence (Christie & Viner, 2005). For instance, girls' and boys' transition from prepuberty to full reproductive capacity,

lasting 18 months to 5 years (MedlinePlus, 2020). Girls begin to develop breast buds and armpit and leg hair around ages 8 and 9 or 10, respectively. Menarche (i.e., first appearance of a menstrual cycle) occurs approximately 2 years after the breast and pubic hair emerge, which may happen as early as age 9 or as late as 16. With regards to boys, their genitals (i.e., testicles, scrotum, and penis) and pubic hair begin to grow as early as 9- and 12-years-old, respectively. Boys also have nocturnal emissions at a mean age of 14. Both genders also experience a significant growth spurt. Girls and boys peak at age 11 and 13, respectively, and decrease at age 16 and 18, respectively (MedlinePlus, 2020).

Given the time differences in the biological variables in boys and girls, researchers have attempted to account for such discrepancy. For example, genetic variants may alter the pubertal timing in the general population (Cousminer et al., 2016). Chronic illnesses, such as cystic fibrosis, diabetes mellitus, asthma, or bowel problems may contribute to a pubertal delay (Yeo & Sawyer, 2005). Females who are overweight may experience the development of their breast buds and menarche at a much younger age than their peers (Li et al., 2017). Lastly, substance use, such as cannabis, may cause an early onset of puberty in males (Rizvi et al., 2015). Biological factors not only influence the physical development of the adolescent, but also to the onset and course of depression too.

Several studies with twins suggest that depressive symptoms are moderately heritable (i.e., 30-50 percent; Boardman et al., 2011; Thapar & Rice, 2006). With regard to the endocrine system, researchers have found that adolescents with depression undergo nocturnal hypersecretion of cortisol (Dahl et al., 1991) and growth hormones (Kutcher et al., 1991), but hyposecretion of dehydroepiandrosterone (Goodyer et al., 1998). Concerning the serotonergic system, there appears to be a relationship between serotonin and depression amongst adolescents.

For example, a negative correlation was found between plasma serotonin levels and suicidal behavior among adolescent psychiatric inpatients (Tyano et al., 2006). Brain morphology may be another biological factor. For example, neuroimaging studies (e.g., magnetic resonance imaging, computed tomography, etc.) indicated that adolescents with depression have smaller frontal lobe volume and higher lateral ventricular volume (Steingard et al., 1996), as well as small left subgenual prefrontal cortex volume (Botteron et al., 2002).

### ***Psychological Variables***

The psychological development of an adolescent involves cognitive, emotional, and moral changes. Although we experience cognitive developments in early childhood (e.g., inductive reasoning per Piaget's Concrete Operational Stage; Piaget, 1952), adolescents develop significant changes in their (a) attention, (b) memory, (c) metacognition, (d) executive function, and (e) social cognition (Levine & Munsch, 2011). With regard to the latter, social cognition plays an important part in the emotional development of the adolescent. They become aware of not only their own emotions, but also the emotions (as well as thoughts and beliefs) of others (Levine & Munsch, 2011). They also learn how to recognize facial expressions too (Herba & Phillips, 2004). Lastly, adolescents begin to develop a sense of morality. According to Kohlberg's Stages of Moral Development (1958), adolescents are at Level 2 (of three), which is known as Conventional Moral Judgment. Adolescents transition from decisions based on self-interest to the laws of society. They internalize the rules of society and make judgments as to either uphold or disobey the law (Kohlberg, 1958).

Unique issues may hinder the psychological development of adolescents. Learning disabilities, specifically attention-deficit/hyperactivity disorder, may present challenges to the adolescent's cognitive development, such as sustaining attention during routine tasks (American

Psychological Association [APA], 2013), which, consequently, may result in poor academic achievement and/or grade retention (Reis et al., 2014; Roy et al., 2017). Stress and trauma both have the potential to adversely impact an adolescent's emotional development (U.S. Department of Health and Human Services, 2018). For instance, affect regulation can be negatively affected by chronic stress and traumatic events (Frydman & Mayor, 2017). Mental health disorders are also a factor to consider with an adolescent's psychological development, particularly depression (Cook et al., 2009).

Lewis and Lewis (1981) noted that early experiences of loss and abandonment may contribute to depressive symptoms in adolescents; where loss pertains to not obtaining something necessary for their well-being, thereby feeling helpless (Joffe & Sandler, 1965), and abandonment refers to the fear of being left alone, particularly by the mother. Temperament has also been linked to depression. In a longitudinal study, adolescents who exhibited "temperamental dimensions of shyness with strangers, sentimentality, and persistence" (Malhotra & Sahoo, 2018, p. 12) were at an increased risk of developing depression (Elovainio et al., 2004). Other psychological influences of adolescent depression center on cognition. More specifically, adolescents begin to develop an increased capacity to reflect. This increased ability may lead to development of a negative body image and thus a depressed mood (Attie & Brooks-Gunn, 1992; Hammen, 1990; Post & Crowther, 1985).

### ***Social Variables***

Social variables are also helpful to understand adolescent development. According to Erikson (1968), developing one's identity in adolescence is the main and most significant task for these individuals. Adolescents begin to conceptualize values and beliefs, experiment with clothing and attitudes, and engage in risk-taking behaviors in order to form their identity

(Tymula et al., 2012). However, this is not done in isolation. In fact, the research on adolescent identity development indicates that it is also related to their peers (Rageliene, 2016). Adolescents transition from dependent and close relationships with the nuclear family to an expansion of their social circles (Friedman, 1993; U.S. Department of Health and Human Services, 2018).

Adolescents begin to increase their social network by forming strong relationships with peers from team sports and school organizations, to name a few, as well as adults outside of the family, who may be viewed as mentors (e.g., teachers, coaches, etc.). As such, “good and supporting relationships with peers is positively related to adolescent identity development because it can help prevent stagnation in the process of identity exploration” (Rageliene, 2016, p. 99).

Despite these social developmental changes, there are some factors that may differ and affect an adolescent’s social development. To illustrate, adolescents experience varying rates of physical development. Therefore, adolescents may either undergo physical changes at either a younger or older age than others, which may result in them being treated and seen as young children or older youth, respectively (U.S. Department of Health and Human Services, 2018). Another factor to consider is peer group influence (commonly known as peer pressure). Peer groups have been shown to influence risk behaviors, including violence, sexual behavior, and substance use (Tomé et al., 2012). Conversely, peer groups may provide a space for the adolescent to share emotions and experiences, learn to solve conflicts, and experience positive results in their academics (Vaquera & Kao, 2008). All of which may contribute to an adolescent’s social development and, in turn, the development and maintenance of depression.

Sociological risk factors of depression in adolescence include stress, family, and peers. Adolescents who experience stressful life events (e.g., health threats) have been associated with depressive symptoms (Stikkelbroek et al., 2016), although it is unclear whether adolescents



actually develop clinical depression secondary to the stressful event (Garnefski et al., 2003). The onset of depression in adolescents has also been associated with the divorce of parents and financial difficulties within the family (Bernaras et al., 2019). Lastly, in a study examining peer relationships during adolescence, Gaspar de Matos et al. (2003) found an association between poor peer relationships and depression in females and adolescents.

Given these variables of depression amongst adolescents, assessment measures may provide clinicians the proper tools to accurately evaluate the adolescent with suspected depression.

### ***Assessment***

According to Price et al. (2015), psychological measures provide a “systematic procedure for assigning scores to individuals...so that those scores represent the characteristic of interest” (p. 61). For example, psychological measures are used to screen adolescents with depressive symptoms in order to ensure accurate diagnosis, as well as track their symptoms throughout treatment and follow-up (Young et al., 2010). But psychological measures cannot simply be systematic. Instead, they must have sufficient reliability and validity across multiple studies in order to demonstrate that the measure actually works (Young et al., 2010).

Several assessment measures have been developed to identify either depressive symptoms or clinical depression in adolescents, such as (a) self-report measures; (b) clinician-administered measures; and (c) semi-structured diagnostic interviews (Young et al., 2010). However, it is recommended to use a multimethod assessment approach (Birmaher et al., 1996). That is to say, the clinician should first use the self-report measures as a screening tool. If the adolescent scores near or above the cutoff score, then the clinician should administer either a clinician-administered measure or semi-structured diagnostic interview. This latter step is

incorporated in order to determine the severity of the depression in the adolescent, rather than simply a dichotomous view of his/her depression with only the self-report measure. That said, the commonly employed self-report measures will be reviewed first.

**Self-Report Measures.** The Beck Depression Inventory (BDI; Beck, 1961; Beck & Steer, 1993) is one of the most often used self-report measures of depression. It is a 21-item measure that was originally developed for adults but is widely used and has strong psychometric properties for adolescents (Ambrosini et al., 1991; Barrera & Garrison-Jones, 1988; Marton et al., 1991; Teri, 1982). It is recommended to use a cutoff score of 16 with adolescents. One of its limitations, however, is assessing the severity of depression, consequently, leading to high false-positive results (Ambrosini et al., 1991; Roberts et al., 1991).

Another common self-report measure is the Children's Depression Inventory (CDI; Kovacs, 1992). It is a 27-item measure that was developed for ages 7 to 18. There is also a parent version of the CDI, which provides information about the caregiver's assessment of the adolescent. The literature indicates good reliability but suspect construct validity. Researchers indicate that the CDI is more of a measure of general distress than depression (Barreto & McManus, 1997).

The Reynolds Adolescent Depression Scale, 2<sup>nd</sup> Edition (RADS-2; Reynolds, 2002) is another commonly utilized self-report measure of depression for adolescents. There are 30 items, specifically based on the criteria of depression from the *Diagnostic and Statistical Manual of Mental Disorders* (DSM, 4<sup>th</sup> ed., text rev, APA, 2000). Similar to the CDI, the RADS-2 also has a parent-report form. A score of 76 indicates significant depression, thereby requiring further diagnostic evaluation with either a clinician-administered measure of semistructured diagnostic interview (Reynolds, 2002).

**Clinician-Administered Measures.** According to Young et al. (2010), the two most frequently used clinician-administered measures of depression in adolescents are: (a) Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960; Warren, 1997) and (b) Children's Depression Rating Scale-Revised (CDRS-R; Poznanski & Mokros, 1985). The HRSD is comprised of 17 items that are scored from 0 to 4 points, and can be completed in approximately 15 to 20 minutes. It has demonstrated sufficient internal, inter-rater, and retest reliability (Bagby et al., 2004). The CDRS-R is also a 17-item scale. It is administered by the treatment provider through an interview with the adolescent and parent. The literature indicates good reliability and validity for adolescents with depression (Mayes et al., 2010).

**Semistructured Diagnostic Interviews.** The most common semistructured diagnostic interview is the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime (SADS-PL; Lauth et al., 2010). The KSADS-PL is widely used for ages 6 to 18. The clinician interviews the adolescent then the parent(s). Although it is an interview, the manual recommends not recite the questions. Instead, the clinician should use the prompts as ways to obtain the necessary information for scoring. The research suggests that it has good reliability and validity data for the use with adolescents (Lauth et al., 2010).

### ***Treatment***

In addition to assessment, there are two primary approaches for the treatment of depression in adolescents: psychopharmacotherapy and psychotherapy (Birmaher et al., 1996). However, “no definitive guidelines have been published for deciding when to begin with medication...[or] psychotherapy” (Tompson et al., 2000, p. 175). Tompson et al. (2000) provided several considerations designed to aid the clinician in deciding the initial treatment approach. For instance, pharmacotherapy should be considered first if the adolescent (a) has

limited cognitive abilities; (b) appears uninterested in discussing his/her difficulties with a psychotherapist; (c) experienced two or more depressive episodes; (d) is unable to attend psychotherapy; (e) has yet to experience any significant results from psychotherapy; or (f) is severely depressed with disruption in his/her vegetative symptoms (e.g., sleep, appetite, etc.). Conversely, psychotherapy should be deemed appropriate as the first-line of treatment if the adolescent (a) dislikes taking pills or fears medication; (b) has contraindications with the antidepressant medication; (c) has yet to respond to a sufficient trial of antidepressant medication; (d) experienced trauma or significant life stressors; or (e) prefers talking about his/her difficulties (Tompson et al., 2000). The following will review the literature pertaining to the efficaciousness of the aforementioned treatment approaches, as well as the differential outcomes for ethnic, racial, and gender minorities.

**Psychopharmacotherapy.** Antidepressant medication is considered the first-line treatment for adolescents in the acute phase of depression (Anderson et al., 2012). Classes of antidepressants include: selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), monoamine oxidase inhibitors (MAOIs), tricyclic antidepressants (TCAs), tetracyclic antidepressants, phenylpiperazine, and bupropion (Anderson et al., 2012). Treatment providers generally prescribe an SSRI first, due in part to its relatively harmless side effects (Birmaher et al., 1998). Two SSRIs have been approved by the Food and Drug Administration for adolescents with depression: fluoxetine and escitalopram. However, fluoxetine has the strongest evidence in the literature, which includes four positive randomized controlled trials (Bridge et al., 2007). Furthermore, two meta-analyses indicated that although all antidepressants have a small therapeutic effect, fluoxetine was the only antidepressant to be

statistically significant in efficacy when compared to placebo (Vitiello & Ordóñez, 2016; Zhou et al., 2018).

**Gender Differences.** There has yet to be a study that specifically examines gender differences in antidepressant medication for adolescents with depression (Weller et al., 2006). Instead, researchers have focused on gender differences in adults. Even so, Sramek et al. (2016) indicated that there is a lack of consensus in the literature about the any possible gender differences.

In a 9-year prospective study with 18 hospitals in South Korea, Yang et al. (2011) sought to determine if there are any gender differences in antidepressant treatment. Participants who were diagnosed with a depressive disorder at the hospital - first-onset or recurrent - were approached for participation. Inclusion criteria required participants to be (a) ages 7 or older and (b) DSM, Fourth Edition (DSM-IV; APA, 1994), diagnosis of depression (e.g., major depressive disorder, dysthymic disorder, depressive disorder not otherwise specified). There were three antidepressant medication categories: SSRIs (e.g., fluoxetine), dual action antidepressants (e.g., bupropion), and other antidepressants (e.g. amitriptyline). Medication, dosages, regimes (e.g., switching one antidepressant to another) was determined by the physician's decision. Outcome measures were administered at baseline and at 1, 2, 4, 8, 12, 24, and 52 weeks. The assessments included: HRSD (Hamilton, 1960), Hamilton Anxiety Rating Scale (Hamilton, 1959), Clinical Global Impression Scale-Severity scale (Guy, 1976), and Social and Occupational Functioning Assessment Scale (Morosini et al., 2000). A total of 723 patients were included in the study, with a majority of the sample being women ( $N = 535$ ). The results, based on the aforementioned outcome measures, suggested that women showed significantly greater response to the antidepressants and, thereby, remission to their depressive disorder than men. They hypothesized

this might be due to physiological factors between the genders, which may, in turn, affect the pharmacokinetics of SSRIs (Bigos et al., 2009). Despite such conjecture, this finding was consistent with prior studies indicating women respond better to antidepressant treatment (particularly SSRIs) than men (Kornstein et al., 2000; Young et al., 2009).

In contrast, some studies suggest males respond better to antidepressants than females. Frank et al. (1988) examined gender differences in patients with recurrent depression. Participants were eligible if they were (a) between the ages of 21 and 65; (b) in their third episode of a major depressive episode, as defined by the Research Diagnostic Criteria (RDC; Spitzer et al., 1978); and (c) endorse a score of 7 or more and 15 or more on the Raskin Severity of Depression (RSD; Raskin et al., 1969) and HRSD (Hamilton, 1960), respectively. All of the study participants ( $N = 230$ ) received the same pharmacotherapy (i.e., imipramine, 150-300 milligrams per day) and were assessed at baseline and weeks 8, 12, and 16. The outcome measures included: HRSD, RSD, Global Assessment Scale (Endicott et al., 1976), BDI (Beck, 1961), and Hopkins Symptom Checklist (SCL-90; Derogatis et al., 1973). Although men ( $N = 50$ ) and women ( $N = 180$ ) were similar with respect to age, age at onset of depression, and quantity of prior depressive episodes, the results suggested significant differences between the genders. That is, “men were [sic] significantly more likely to show a rapid and sustained clinical response than the women” (Frank et al., 1988, p. 44), which is similar to other antidepressant treatment studies (particularly with TCAs) between genders (see Hamilton et al., 1996; Kornstein et al., 2000; Raskin, 1974). In an attempt to explain the findings, the authors suggested it may be due to the reporting of symptoms and/or the psychotherapeutic and pharmacologic nature of antidepressants. With respect to the former, and given the findings were from self-report measures, the authors opined that men may possibly deny their symptoms at greater length than

women, whereas women may willingly acknowledge and express their symptoms than men. Consequently, statistical analysis of the self-report measures may indicate men as responding more favorably to the antidepressant than women (Frank et al., 1988).

On the other hand, some studies do not detect any gender differences whatsoever. For instance, Quitkin et al. (2002) analyzed a 20-year data set from an outpatient depression research clinic. The data was comprised of 1,746 participants and 9 studies. All of the studies, with the exception of one, were randomized, double-blind 6-week trials of TCAs and MAOIs. The remaining study investigated fluoxetine. Participants were between the ages of 18 and 65 and were assessed with the following outcome measures: RDC (Spitzer et al., 1978), DSM (3<sup>rd</sup> ed.; APA 1980) or DSM (3<sup>rd</sup> ed., rev.; APA, 1987) dependent upon the year of the study major depression disorder criteria, HRSD (Hamilton, 1960), Clinical Global Impression Scale (CGIS; Guy, 1976), and SCL-90 (Derogatis et al., 1973). Based upon the results, the authors reported that there were no gender differences in the efficacy of fluoxetine, TCAs, and MAOIs. Over the years, this has been seen in other studies that fail to show any gender-based efficacy differences, whether it is between MAOIs and TCAs (Himmelhoch et al., 1991), SSRIs and SNRIs (Entsuah et al., 2001), or SSRIs, TCAs, and other antidepressants (Cuijpers et al., 2014). Overall, it appears the literature is at odds about whether or not gender differences exist in pharmacological treatment of depression.

***Racial and Ethnic Differences.*** “Information about the differences between White and minority youth in the pharmacodynamics and pharmacokinetics of the antidepressant response is still limited” (Stewart et al., 2012, p. 72). As such, research has focused on the adult population and the racial and ethnic differences in their antidepressant response, which has been mixed thus far (Lesser et al., 2010).

Some studies suggest there are no racial or ethnic differences in either outcome or speed of response to antidepressants. In an 8-week, clinical trial of citalopram, Lesser et al. (2010) recruited African American ( $N = 184$ ) and Caucasian ( $N = 143$ ) adults who (a) met DSM-IV criteria for current major depressive episode (per the Structured Clinical Interview; SCID; First et al., 1996) and (b) endorsed a score of  $\geq 17$  on the HRSD (Hamilton, 1960). Citalopram was initially prescribed at 20 milligrams per day. However, depending upon treatment response and/or side effects, treatment providers were able to increase the dosage to 40 and 60 milligrams at week 4 and 7, respectively. The subjects also underwent the following outcome measures at baseline and termination: BDI (Beck, 1961), CGIS (Guy, 1976), and Treatment Emergent Symptoms Scale (Guy, 1976). Although there were differences in demographics (e.g., years of education) and severity of depression at baseline, the results indicated similar outcomes between the two racial and ethnic groups. The researchers hypothesized that if treatment providers focus on the symptoms and side effects reported by their patients, thereby changing the dosages of the medication, then racial and “ethnic disparities in treatment outcomes can be attenuated” (Lesser et al., 2010, p. 5).

In a follow-up study, Lesser et al. (2011) investigated if outcomes differ by race and ethnicity in a 12-week study with three distinct antidepressant dosage protocols. Patients were recruited from nine psychiatric and six primary care sites. Inclusion criteria required participants to: (a) be 18- to 75-years-old, (b) meet criteria for current or recurrent major depressive disorder (based on a clinical interview and DSM-IV symptom checklist), and (c) endorse a score of  $\geq 16$  on the HRSD (Hamilton, 1960). Baseline data included illness features and sociodemographic variables (e.g., race and ethnicity). Subjects were randomly assigned to one of the following dosing protocols: escitalopram and placebo, bupropion-sustained release and escitalopram, or



venlafaxine-extended release and mirtazapine. Clinic visits, which included outcome measures and dosage adjustments, occurred at baseline and weeks 1, 2, 4, 6, 8, 10, and 12. The primary treatment outcome was measured by the Quick Inventory of Depressive Symptomatology-Clinician-rated (QIDS-CR; Rush et al., 2003). The sample was separated into three race and ethnicity groups: white ( $N = 352$ ), black ( $N = 169$ ), and Hispanic ( $N = 79$ ). Similar to the prior study, significant demographic and socioeconomic differences existed between the three racial and ethnic groups. However, regardless of the antidepressant medication regime, outcomes were similar. That is to say, no differences were found in the antidepressant response across the racial and ethnic groups (Lesser et al., 2011).

In contrast to similarities, clinical trials also indicate differences amongst racial and ethnic groups. To illustrate, the Sequenced Treatment Alternatives to Relieve Depression (STAR\*D) compared rates of remission and outcomes of an antidepressant between Hispanics ( $N = 327$ ), African Americans ( $N = 495$ ), and Caucasians ( $N = 1,853$ ; Lesser et al., 2007). Patients were eligible if they were between the ages 18 to 75 and endorsed a score of  $\geq 14$  on the HRSD (Hamilton, 1960). Outcome measures related to depressive symptomatology were completed after each clinical visit (i.e., weeks 1, 2, 4, 6, 9, and 12), which included (a) HRSD (Hamilton, 1960); (b) Inventory of Depressive Symptomatology-Clinician (Trivedi et al., 2004); (c) QIDS-CR (Rush et al., 2003); and (d) Quick Inventory of Depressive Symptomatology-Self-Report (QIDS-SR; Rush et al., 2003). The results of the clinical trial indicated poorer responses and rates of remission for the African American subjects when compared to the Hispanic and Caucasian patients. The authors speculated that sociocultural (e.g., traumatic experiences) and biological factors (e.g., genetics) may explain these findings (Lesser et al., 2007). With regards to the latter, Murphy et al. substantiated this hypothesis with a sample of the STAR\*D

participants' DNA who were treated with citalopram (2013). Participants ( $N = 1,953$ ) were separated into three racial categories: African American ( $N = 299$ ), White ( $N = 1,464$ ), and other ( $N = 114$ ). The QIDS-CR and QIDS-SR outcome measures were analyzed at baseline and termination. The results suggested that “[g]enetic African Ancestry predicted lower treatment response” when compared to the White and other groups (Murphy et al., 2013, p. 2,598).

**Psychotherapy.** Amongst the psychological treatments for adolescents with depression, cognitive behavioral therapy (CBT) and interpersonal psychotherapy (IPT) are the most examined (Thapar et al., 2012). For example, Smith et al. (2015) examined the efficacy of a computerized, individual-format CBT program “Stressbusters” for adolescents with depression. Participants were initially screened for depressive symptoms using the Mood and Feelings Questionnaire Child Report (MFQ-C; Angold et al., 2002). Those who reported experiencing significant symptoms of depression on the MFQ-C (i.e.,  $\geq 20$ ) were placed in a randomized control trial (ages 12-16;  $N = 112$ ) between either the Stressbusters or waiting list group for a total of eight weeks. Participants, parent(s), and teachers were administered outcome measures at baseline, termination, and 3- and 6-months follow-up. Outcome measures for the participants included the MFQ-C, Screen for Child Anxiety Related Disorders (Birmaher et al., 1997), and Child Response Styles Questionnaire (Abela et al., 2000); parent(s) completed the Mood and Feelings Questionnaire (Angold et al., 2002) and Screen for Child Anxiety Related Disorders (Birmaher et al., 1997); and teachers were provided the Strengths and Difficulties Questionnaire (Goodman, 2001). By the conclusion of the study, not only did the results from the aforementioned outcome measures indicate that Stressbusters was an efficacious CBT program for adolescents with depression, but the benefits lasted at both the 3- and 6-month follow-up (Smith et al., 2015).

There is also literature indicating that CBT may be effective for adolescents with depression when it is delivered in a group-based format. To illustrate, Garvik et al. (2014) investigated the effectiveness of a CBT group titled Adolescent Coping with Depression. It was an 8-week course that utilizes a psychoeducational approach with a standardized manual. Adolescents were initially screened using the BDI (Beck, 1961) and a brief clinical interview. Those who endorsed a score of  $\geq 10$  on the BDI and were between the ages of 15 to 21 were included in the study, which was a total of 107 subjects. The BDI was the only outcome measure. Participants completed the measure at baseline, termination, and 6-month follow-up. There were reductions in depressive symptomology for not only at the termination of the study, but also at the six months follow-up, based on the results from the BDI. Consequently, the authors concluded that a group-based CBT course for adolescents with depression was effective (Garvik et al., 2014).

Meta-analyses of CBT for adolescents with depression have also indicated similar results. Klein et al. (2007) conducted a meta-analysis in order to evaluate the acute and follow-up effects of CBT for adolescents with depression. Their inclusion criteria included (a) ages of participants was between 12 and 18; (b) use of CBT as an intervention; (c) diagnoses of depressive disorder based on either the DSM (3<sup>rd</sup> ed.; APA, 1980), Bellevue Index of Depression criteria (Petti, 1978), or RDC (Feighner et al., 1972); (d) participants randomly assigned to either a CBT or control or other psychotherapeutic group; (e) pre- and posttest outcome data for both groups; and (f) material written in English. Their search generated a total of 11 randomized controlled trials with a variety of populations (e.g., youth in juvenile settings), treatment modalities (e.g., group CBT), and controlled conditions (e.g., medication placebo). Based upon their statistical analyses,

the results suggested that although CBT may be beneficial for the acute treatment of depression in adolescents, the follow-up effect sizes could not be interpreted (Klein et al., 2007).

In addition to the efficacious literature on CBT, IPT has also shown promise for both individual and group formats (see O'Shea et al., 2015) in the treatment of adolescents with depression (Mufson et al., 1999). For instance, Mufson et al. (2004) conducted a randomized, controlled trial in five school-based mental health clinics in New York City, New York. Subjects were initially administered the HRSD (Hamilton, 1960) and Children's Global Assessment Scale (CGAS; Shaffer et al., 1983), as well as a clinical interview in order to ensure the subjects meet criteria for either (a) dysthymia, (b) major depressive disorder, (c) adjustment disorder with depressed mood, or (d) depression disorder not otherwise specified. Eligible participants ( $N = 63$ ) were randomly assigned to either the IPT or wait list group for 16-weeks. The following measures were included in the study: Social Adjustment Scale-Self-Report (Weissman, 1999), CGIS (Guy, 1976), CGAS (Shaffer et al., 1983), BDI (Beck, 1961), and HRSD (Hamilton, 1960). Results of the study indicated that adolescents with depression, and treated with IPT, reported a decrease in their depressive symptoms and increase in functionality. Consequently, Mufson et al. (2004) stated that IPT, particularly in a school-based mental health clinic, is effective for the treatment of depression in adolescence.

Adaptations of IPT have been modified to fit group formats, particularly for adolescents with depression (Mufson et al., 2004). Bolton et al. (2007) assessed the efficacy of IPT as a group treatment (IPT-G) in Uganda. However, given the fact that Ugandan culture is distinct to the culture of the United States, researchers developed two local measures: (a) Acholi Psychosocial Assessment Instrument and (b) functional outcome measure, both of which were to reflect the unique depressive symptoms and common activities of adolescents, respectively, in

Uganda. Screening was conducted in two steps. First, the researchers contacted local teachers, workers, leaders, etc. to develop a list of adolescents who they believed exhibits at least one local depressive symptom (e.g., *par*, which equates to suicidal thoughts, lack of concentration, and irritable). Subsequently, those from the lists ( $N = 667$ ) were administered the two locally developed outcome measures. Those who endorsed a score greater than 32 on the depressive scale and at least one on the functional measure, were included ( $N = 304$ ). The adolescents were randomly assigned to one of three groups: IPT-G, creative play (CP), or wait-list control for 16 weeks. Outcome measures were given at baseline, termination, and 1-month follow-up. Result of the study suggested that IPT-G was superior in the reduction of depressive symptoms to the CP and wait-list control group, both at termination and 1-month follow-up (Bolton et al., 2007).

Recently, a pair-wise meta-analysis was conducted to determine both the effectiveness and acceptability of IPT for adolescent with depression (Pu et al., 2017) - acceptability was measured by drop-out rates. The inclusion criteria required the studies (a) to be randomized controlled trials; (b) include adolescents with either a clinical diagnosis of depression or significant depressive symptoms on a depression outcome measure; and (c) have a control group (e.g., waitlist). They also evaluated three outcomes: (a) depression rating scales, (b) quality of life/functional improvement, and (c) suicide-related outcomes. Their search identified a total of 2,607 potential articles, but only seven met the inclusion criteria. With regards to the results, the data suggested that IPT is both efficacious in decreasing depressive symptoms in adolescents and has lower drop-out rates when compared to the control groups. Lastly, patients who participated in the IPT groups endorsed a significant improvement in their quality of life and functioning (Pu et al., 2017).

The aforementioned review suggested that both CBT and IPT are effective psychotherapeutic treatments for adolescents with depression. However, is one better than the other, either as a group or individual format? In order to answer such a question, Rosselló et al. (2008) conducted a study titled “Individual and Group CBT and IPT for Puerto Rican Adolescents with Depressive Symptoms.” They recruited adolescents from schools in San Juan, Puerto Rico, which resulted in 322 referrals. Eligibility was based on age (12- to 18-years-old) and meeting criteria for major depressive disorder from either the (a) DSM (3<sup>rd</sup> ed., rev.; APA, 1987) diagnostic criteria; (b) clinical interview; or (c) endorsed a score of 13 or greater on the CDI (Bernal et al., 1997). The subjects of the study ( $N = 112$ ) were randomly assigned to one of four conditions: IPT-Individual (IPT-I), IPT-G, CBT-Individual (CBT-I), or CBT-Group (CBT-G). Separate and detailed manuals were created for all four treatment conditions. The outcomes measures, which were administered at baseline and termination, included: CDI (Bernal et al., 1997), Piers-Harris Children’s Self-Concept Scale (Piers & Harris, 1984), Child Behavior Checklist, Adolescent and Parent version (Achenbach, 1983; Bird et al., 1987), Social Adjustment Scale for Children and Adolescents (Beiser, 1990), and Diagnostic Interview Schedule for Children (Bravo et al., 1993). While treatment lasted 12 weeks, once per week, for all four groups, the length of sessions per week varied between groups. While the individual treatment conditions met for 1-hour sessions, the group treatment was for 2 hours per week. Results of the study, based on the aforementioned outcome measures, suggested that although all of the treatment conditions were effective in the reduction of depressive symptoms, “CBT produced significantly greater decreases than IPT” (Rossello et al., 2008, p. 241). There were no statically significant differences between the individual and group formats.

**Gender Differences.** According to Weller et al., “studies of gender differences in treatment response in...adolescents [with depression] are not available” (2006, p. 108). There is, however, scarce research in adults (Kornstein, 1997).

In a study titled “Do Depressed Men and Women Respond Similarly to Cognitive Behavior Therapy?” Thase et al. (1994) investigated the impact of gender on its response to psychotherapy. Inclusion criteria required the subjects to have met the Research Diagnostic Criteria for major depressive disorder (Spitzer et al., 1978), endorsed a score of  $\geq 14$  on the HDRS (Hamilton, 1960), did not have any poorly managed medical conditions known to contribute to depression (e.g., hypothyroidism), no history of substance use, and were not deemed to have a personality disorder (e.g., borderline). Men ( $N = 40$ ) and women ( $N = 44$ ) were both treated with CBT for 16 weeks for a total of 20 sessions - twice weekly for the first 4 weeks then once a week thereafter. Treatment outcomes were conducted every other week. Assessments included the HRSD (Hamilton, 1960), BDI (Beck, 1961), and Global Assessment Scale (Endicott et al., 1976). Results of the study indicated several pre- and during treatment differences; for example, women endorsed higher levels of depression than men and men attended fewer psychotherapy sessions than women. In light of these differences, Thase et al. (1994) concluded that, overall, men and women with major depressive disorder had similar outcomes when treated with CBT. These findings corroborate other studies in which gender does not predict response or remission rates, in both CBT (Jarrett et al., 1991) and IPT (Thase et al., 1997).

Thase et al. (2000) provided possible reasons for the lack of research on the impact of gender in psychotherapy outcomes. For example, several psychotherapy modalities, specifically for depression, were originally and specifically developed for the treatment of women. Thus, men were excluded from these trials. Also, psychotherapy studies generally recruit a small

number of participants (e.g., 30), with at least 75% of the sample being women. It is, thereby difficult to adequately calculate clinically relevant gender differences in either remission or response rates to the psychotherapeutic treatment of depression (Thase et al., 2000).

***Racial and Ethnic Differences.*** “Few studies have compared racial/ethnic differences in the outcomes from mental health treatment” (Alegria et al., 2010, p. 766) in adolescents, let alone adolescents with depression. One depression-related study with adolescents was mentioned in Miranda et al. (2005) report titled “State of the Science on Psychosocial Interventions for Ethnic Minorities.” The authors commented on a prior experiment in which poorer outcomes were found in the prevention of depression in African American youth when compared to Asian, Latino, and White adolescents. However, further details pertaining to this study are unavailable due to the omission of a citation in the article.

In addition to the depression prevention study, Baker (2003) investigated if, at all, mental health outcomes differ between race and ethnic youth in a metropolitan community in California. The sample consisted of 1,412 youth (ages 3 to 18). Racial and ethnic groups were separated into four groups: White, Hispanic, African-American, and Asian/Pacific Islander. Subjects of the study received “community based mental health outpatient services” (Baker, 2003, p. 8) for at least 6 months from 1997 to 2001. Details of the services were not disclosed. Outcome measures were administered at baseline and termination (i.e., 6 months), which included Child and Adolescent Functional Assessment Scale (Hodges & Wong, 1996), Child Behavior Checklist (Achenbach, 1991a), and Youth Self Report (Achenbach, 1991b). Data obtained from the study suggested similar baseline symptoms and impairments across all of the racial and ethnic groups. But, based on the outcome measures, the Asian/Pacific Islander youth markedly improved on both clinical and functional measures than the other racial and ethnic groups. Baker (2003)



concluded race and ethnicity may have an impact on mental health outcomes, thereby clinicians need to be aware of the race and ethnicity of their clients, as such factors may influence symptom improvement.

The aforementioned pharmacological and psychological studies indicated equivocal response and remission rates for adolescents with depression. Dunn and Weintraub noted that adolescents who are “most positive responders posttreatment [may] have many residual symptoms, significant functional impairment, and high rates of relapse” (Dunn & Weintraub, 2008, p. 507). Consequently, the authors suggested that exercise may have the potential to not only be incorporated in lieu of psychotherapy, but also as an adjunct to psychotherapy. This promising treatment should be further explored and developed in order to evaluate its efficacy and possible health benefits for the adolescent population.

**Exercise.** According to Hays and Sime (2014), exercise is an organized and focused physical activity with a specific amount of exertion. In comparison to movement, which is random, and sport, which is competitive, exercise can be either passive or active muscle exertion. It utilizes small or large muscle mass and taxes the aerobic or anaerobic metabolic systems. Exercise has been incorporated into mental health treatment in one of three ways: (a) exercise as psychotherapy, (b) exercise as an adjunct to psychotherapy, and (c) exercise during psychotherapy (Hays & Sime, 2014). The following will review the efficacy of exercise as a treatment modality for adolescents with depression.

***Exercise as Psychotherapy.*** This refers the utilization of exercise in lieu of psychotherapy. Dopp et al. (2012) conducted a 12-week aerobic exercise intervention in order to determine if exercise was feasible and efficacious for adolescents with depression. All of the adolescents ( $N = 13$ ) were subject to similar aerobic exercises, such as running or biking, and

durations (i.e., 45-60 minutes, 3 times per week). Assessments were conducted at pre- and post-intervention, which included a self-report (i.e., QIDS-SR; Rush et al., 2003) and clinician-administered measure (i.e., CDRS-R; Poznanski et al., 1985). Significant reductions were found at the post-intervention on both measures and by all subjects. However, one of the limitations of this study is the fact that there was no control group. Thus, the authors argued that it is difficult to ascertain if the reductions in depression were secondary to exercise or another factor (Dopp et al., 2012). In a 6-week randomized control trial, Roshan et al. (2011) investigated the effects of walking in water on female adolescents with clinical levels of depression per the HRSD (Hamilton, 1960). Subjects were randomly assigned to either (a) walking in a pool for 3 days per week or (b) control group, of which “did not participate in any exercise program and did not receive any anti-depressant treatment” (Roshan et al., 2011, p. 27). Based upon pre- and post-intervention scores on the HRSD, there were significant reductions in reported depressive symptoms in the walking in water group in comparison to the no-treatment control group (Roshan et al., 2011). Jeong et al. (2005) conducted a 12-week, randomized control trial with adolescent females who endorsed significant symptoms on the BDI (Beck, 1961). Subjects were randomly assigned to either (a) dance group or (b) control group. The dance group exercised for 45 minutes, 3 times per week for 12-weeks, whereas the control group was described as “did not participate in the treatment described earlier” (Jeong et al., 2005, p. 1,715). Those who received the exercise intervention reported significant reductions in depressive symptoms at post-intervention based on the SCL-90 than the controls (Derogatis et al., 1973).

In addition to the positive results reported at post-intervention, follow-up studies also indicated similar outcomes. Hughes et al. (2013) conducted a randomized control trial that examined the efficacy of a 12-week, randomized control trial of an aerobic exercise intervention

for adolescents who met criteria for major depressive disorder per the DSM (4<sup>th</sup> ed., text rev.; APA, 2000). Adolescents were randomly separated into either (a) aerobic exercise (e.g., jogging) or (b) control stretching for three times per week. The primary measure was the CDRS-R (Poznanski & Mokros, 1996), which was administered at baseline and weeks 3, 6, 9, and 12, as well as follow-ups at 6- and 12-months. Based on the CDRS-R scores, both groups reported reduced depressive symptoms. However, the exercise group had higher response and remission rates at post-intervention and the 6- and 12-month follow-ups when compared to the control (Hughes et al., 2013). In a 6-week, randomized control trial, Carter et al. (2015) investigated the effectiveness of an exercise intervention on adolescents with depression. Adolescents ( $N = 87$ ) were randomly assigned to either (a) aerobic exercises (e.g., body-weight squats; 2 times per week) or (b) treatment as usual. The latter group received either psychotherapy or pharmacotherapy, exercise for the controls was not permitted during the trial. The primary outcome measure was the Children's Depression Inventory, Second Edition (CDI-2; Kovacs, 2011), which was administered at baseline, post-intervention, and 6-month follow-up. Although the CDI-2 scores suggested that exercise was not superior to the control group at post-intervention, depressive symptoms significantly decreased at the 6-month follow-up for the exercise group (Carter et al., 2015).

The aforementioned studies examined the impact of exercise at post-intervention and follow-up. Meta-analyses also offer insight into exercise as an intervention for adolescent with depression. In a systematic review titled "Should We Recommend Exercise to Adolescents with Depressive Symptoms? A Meta-analysis," Radovic et al. (2017a) investigated how, if at all, exercise reduces symptoms of depression among adolescents (ages 12 to 18) when compared to a control group. They retrieved a total of 6,631 studies, but only eight studies (published between

1982 and 2013) met the inclusion criteria. Outcome measures and control groups varied between studies. The outcome measures included the BDI (Beck, 1961), CDRS-R (Poznanski & Mokros, 1996), Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), and HRSD (Hamilton, 1960). Comparison groups ranged from no treatment, resistance exercise, psychosocial rehabilitation, and consultations with a nutritionist. Based on a random effects model, their meta-analysis indicated that exercise has a moderate, but significant effect on the reduction of depressive symptoms on adolescents who participated in the exercise group (Radovic et al., 2017a). Carter et al. (2016) conducted a meta-analysis on the use of exercise as an intervention for depression in adolescents (ages 13 to 17). A total of 11 studies met the inclusion criteria, but only eight were eligible for the meta-analysis. The studies included at least one comparison condition (e.g., no treatment), validated outcome measure of depression, and were randomized control trials or individual or cluster randomization. The outcome measures across the selected studies included Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), BDI (Beck, 1961), CDI-2 (Kovacs, 2011), CDRS-R (Poznanski & Mokros, 1996), SCL-90 (Derogatis et al., 1973), CDI (Kovacs, 1992), HRSD (Hamilton, 1960), Behavior Assessment for Children-2 (Reynolds & Kamphaus, 2004), and Beck Youth Inventories, Second Edition (BYI-2; Beck et al., 2005). Because of the heterogeneity in the outcome measures, the authors calculated a standardized mean difference (SMD) between the experimental and control groups in order to measure treatment effects. Overall, the SMD suggested that there is a significant moderate effect on depressive symptom reduction in the exercise groups (Carter et al., 2016).

In another systematic review, Larun et al. (2006) examined the efficacy of exercise for the prevention and treatment of depression in adolescents and young adults up to 20-years-old.

The selected studies (total of 16) included both high and low intensity exercise when compared to no intervention. Although the researchers' concluded a small effect of exercise in the reduction of depression, the methods, interventions, and clinical diversity of the selected studies was too limited to reach any further conclusions. In an effort to update the evidence of Larun et al. (2006) study, Brown et al. (2013) conducted a meta-analysis of the available and relevant literature up to May 2011 (i.e., efficacy of exercise on adolescents with depression). The inclusion criteria required studies to have participants aged 5 to 19, quantitative measure of depression, and control or comparison group, as well as be published in a peer-reviewed journal. A total of 388 articles were identified through the search, but only 9 met the aforementioned inclusion criteria. Of the selected studies, the quantitative measures of depression included: Profile of Mood States-Short Form (Curran et al., 1995), HADS (Zigmond & Snaith, 1983), CDI (Kovacs, 1992), BDI (Beck, 1961), Short Moods and Feelings Questionnaire-Children (Angold & Costello, 1987), and Reynolds Child Depression Scale (Reynolds, 1989). Based on "a random effects model using Hedges'  $g$  as the effect size index," (Brown et al., 2013, p. 197) Brown et al. conclusion paralleled that of Lauren et al. (2006; i.e., a small effect size).

The aforementioned meta-analyses indicated a small to moderate effect on depressive symptom reduction in adolescents. Wegner et al. (2020) conducted a systematic review of meta-analyses in order to evaluate the impact of exercise on both clinical and nonclinical adolescents with depression. Meta-analyses were deemed appropriate if there were control groups, reported effect sizes, and randomized control trials, cluster randomized controlled trials, controlled trials, or longitudinal studies. Their search identified 1,941 studies, but only four met the eligibility criteria. Several outcome measures of depression were included in the studies of the meta-analyses, but the most frequently used was BDI (Beck, 1961). The authors found an overall

medium effect size, based on Cohen's criteria (Cohen, 1992), for the use of exercise in the reduction of depressive symptoms in adolescents.

***Exercise as an Adjunct to Psychotherapy.*** This pertains to exercise in conjunction with psychotherapy. Leer (1980) asserted that exercise should not be an alternative to psychotherapy, but instead in addition to treatment. He considered exercise as a “complementary measure” to psychotherapy (Leer, 1980, p. 24). This was furthered by Sime and Sansteadt (1987), who suggested that a multimodal approach to mental health treatment, which includes exercise, may produce greater results if either intervention were separately offered. However, only a small number of studies have investigated the effects of exercise in conjunction with psychotherapy for adolescents with depression, of which, mixed results are seen in the literature.

Radovic et al. (2017b) examined if the addition of a 4-week aerobic exercise program, as an adjunct to psychotherapy, contributes to the reduction in depressive symptoms in adolescents. The study incorporated multiple baselines in order to “control for the effects of participants existing treatments and natural recovery” (p. 141). Therefore, participants were assessed at three separate time periods:

1. Beginning of baseline period (Time 1),
2. Ending of baseline period/beginning of intervention (viz. pre-intervention; Time 2),
3. Ending of intervention (viz. post-intervention; Time 3).

The primary outcome measure was the CDRS-R (Poznanski et al., 1985); secondary depression outcome measures included the KSADS-PL (Lauth et al., 2010) and RADS-2 (Reynolds, 2002). All participants ( $N = 10$ ) underwent psychotherapy throughout the entirety of the study; details pertaining to the mental health treatment were not provided. Adolescents also participated in aerobic exercise for 30 minutes per day, three times per week for 4 weeks. Based on the primary

depression outcome measure, depressive symptoms remained stable from Time one to Time two, but significantly decreased at post-intervention.

Hilyer et al. (1982) conducted a randomized control trial that examined the efficacy of a 20-week exercise intervention with counseling among 30 adolescent male offenders. The experimental subjects ( $N = 23$ ) underwent (a) counseling, (b) exercise, and (c) rehabilitation treatment for 1.5 hours a day, 3 days per week. Details pertaining to the counseling were limited. The authors only indicated that there was a strong emphasis on behavioral reinforcement. The controls ( $N = 20$ ) were only provided the rehabilitation treatment. Of which, the frequency and duration of their sessions were absent in the article. All subjects were given a battery of psychological measures pre- and post-intervention, which included: Self-Esteem Inventory - Form A (Coopersmith, 1967), Profile of Mood States (McNair et al., 1971), State-Trait Anxiety Inventory for Children (Spielberger et al., 1973), and BDI (Beck, 1961). Based on these measures, the results of the study suggested that the combination of exercise and counseling was effective in decreasing psychological symptoms, such as depression (Hilyer et al., 1982).

In a 15-week randomized control trial, Melnyk et al. (2013) evaluated the efficacy of the Creating Opportunities for Personal Empowerment (COPE) Healthy Lifestyles Thinking, Emotions, Exercise, Nutrition (TEEN) program with the addition of aerobic exercise. COPE is a cognitive-behavioral skill-building program that is based on cognitive theory. Adolescents ( $N = 779$ ) were randomly assigned to either the COPE Healthy Lifestyles TEEN group ( $N = 358$ ) or an attention control Healthy Teens program ( $N = 421$ ). COPE sessions entailed content - such as the thinking, feeling, and behaving triangle - and 15 to 20 minutes of exercise (e.g., walking). Conversely, the control group only received content related to common issues for teens (e.g., road safety); exercise was not incorporated into the control group. Based on the BYI-2 (Beck et

al., 2005), there were no significant differences in depressive symptoms between the groups at either post-intervention or the 6-month follow-up (Melnyk et al., 2013).

***Exercise During Psychotherapy.*** This is also known as exercise psychotherapy and walk and talk therapy (Carlstedt, 2009). The practitioner (with expertise in exercise psychology and physiology) will exercise - in most cases, walk - together with the patient during the treatment session (Hays, 1999). Acting as a consultant, the therapist will provide exercise advice, encouragement, support, and prescriptions, as well as be a role model for the patient - demonstrating that exercise can be used as a mechanism of change in order to prevent and treat mood disturbances (Sime, 2002). The practitioner will also encourage the patient to exercise between therapy sessions, in the hopes of establishing a regular routine that may continue post termination of therapy (Hays, 1999; Johnsgard, 2004). At present, the research in this specific modality is in its infancy (Revell & McLeod, 2017). To date, only one study has examined its efficacy. Doucette (2004) investigated walk and talk psychotherapy with adolescents (ages 9 to 13) in a middle school in Canada. He simultaneously engaged the adolescents in a counseling session (with humanist principles, e.g., Roger's unconditional positive regard) and mild aerobic exercise. Neither standardized outcome measures nor a control group were included in the study. Instead, pre- and posttreatment interviews were conducted, which required the subjects to draw themselves performing an activity and write their strengths and weaknesses. Doucette consulted with a licensed art therapist to examine the portraits. The results suggested that the students experienced "more feelings of self-efficacy and well-being" (Doucette, 2004, p. 373). The remaining research of walk and talk psychotherapy centers on practitioners' experience and perceptions of the practice. For instance, clinicians noted benefits for rapport building



(DeAngelis, 2013), collaboration in the therapeutic process (Revell & McLeod, 2016), and enhanced experiential processing (McKinney, 2011).

### **Summary**

Adolescents experience several physiological, social, and psychological changes in their development. While some may begin puberty, others may develop a mental disorder, such as depression. Adolescents with depression is a global issue. It impairs their academic and social functioning. Psychological assessment and treatments have been extensively examined to evaluate and treat such patients. The efficacy of psychopharmacotherapy and psychotherapy on adolescents, as well as gender and racial minorities, produced equivocal findings. Furthermore, Dunn and Weintraub (2008) noted that adolescents continue to report residual symptoms, significant impairment, and high rates of relapse with the aforementioned treatment modalities. Consequently, alternative treatments should be explored and developed. One promising treatment is exercise.

Exercise has been incorporated into treatment for adolescents with depression in one of three forms: exercise in lieu of psychotherapy, exercise as an adjunct to psychotherapy, and exercise during psychotherapy. Based on several depression outcome measures (e.g., BYI-2; Beck et al., 2005), adolescents who participate in exercise reported significant reductions in their depression and/or depressive symptoms. However, several components of exercise as a mental health treatment remain unclear, such as the differences between (a) post-intervention and follow-up response and remission rates; (b) exercise in lieu of psychotherapy or exercise as an adjunct to psychotherapy; and (c) response and remission rates amongst minority gender and racial and ethnic groups. Consequently, this systematic review of the literature will aim to address such unexplored topics on the impact of exercise on adolescents with depression.

## Theoretical Framework

The conceptual and theoretical framework of the present study is the biopsychosocial model, which is an interdisciplinary model that examines the connection between biology, psychology, and socio-environmental factors (Engel, 1977). As previously noted, genetic and biological factors have been linked to depression amongst adolescents. Based on twin studies, depression appears to be moderately inheritable (Rice et al., 2002), and identical twins are more likely to develop depression than fraternal twins (Kendler et al., 1986). Molecular genetic studies suggest that adolescents with depression have “an excess of the SS-genotype...and of the S-allele” (Nobile et al., 2004, p. 292). Regarding biomarkers, there are contradictory reports regarding brain-derived neurotropic factor (BDNF), serum, and folate levels in adolescents with depression. For example, while Tsuchimine et al. (2015) did not find any differences in BDNF levels between the depressed group and controls, Bilgiç et al. (2020) found significantly higher levels of BDNF in adolescents with depression when compared to the control subjects.

In addition to the genetic and biological markers associated with depression in adolescents, exercise appears to reduce such mood symptoms. Nabkasorn et al. (2006) evaluated how exercise may improve physiological and psychological factors in depressed adolescent females. Their results suggested that exercise not only improved depressive symptoms, based on the CES-D scale (Radloff, 1977), but also decreased cortisol and epinephrine levels in the female participants. Another study evaluated the impact of exercise on neurotransmitters in schoolchildren with depression (Alghadir et al., 2016). Upon the conclusion of their study, they found a correlation between increased exercise and decreased depressive symptoms, based on the CDI (Kovacs, 1992), and cortisol and serotonin levels.

With regards to psychological factors, research indicates associations to depression and personality/temperament and cognitive of adolescents. Del Barrjo et al. (1997) investigated personality traits and depression among Spanish adolescents. Based on the CDI (Kovacs, 1992) and Spanish version of the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975), there was a significant positive correlation between neuroticism, extraversion, and depression. There are several cognitive vulnerability factors in adolescents with depression that have received extensive attention, one of which is rumination. Hankin (2008) conducted a multiwave study to examine the extent rumination predicted depressive symptoms in adolescents. Results from his study, based on the CDI (Kovacs, 1992) and Children Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991), indicated rumination increases depression in adolescents, which has been suggested to maintain depression as well (see Park et al., 2004).

The incorporation of exercise appears to be of benefit for the psychological well-being of adolescents with depression. Koniak-Griffin (1994) evaluated the effects of a 6-week exercise program on pregnant adolescents with depression and low self-esteem. Her results, based on the CES-D (Radloff, 1977) and Coopersmith's Self-Esteem Inventory (Coopersmith, 1967), indicated that exercise decreases depressive symptoms and increases self-esteem, which may be an important aspect of self-care for the pregnant adolescent population. This finding was furthered with low-income Hispanic children (Crews et al., 2004), who are a high-risk population for developing mental illness, including depression (Jerstad et al., 2010). Studying 66 children in grade 4, participants were randomly assigned to either an aerobic intensity or control physical activity program. At the conclusion of the study, there were significant decreases in depression and greater self-reported self-esteem in the children who were exposed to the aerobic intensity

group when compared to the control, based on the BDI (Beck, 1961) and Rosenberg Self-esteem scales (Rosenberg, 1965).

Sociological factors include family and peers. Regarding family, depressive symptoms in children have been linked to dysfunctional parent-child interactions (Burge & Hammen 1991), marital conflict (Downey & Coyne, 1990), decreased family cohesion and expression (Friedrich et al., 1982), and family conflict (Carlton-Ford Paikoff & Brooks-Gunn, 1991). Adolescents are at a higher risk of developing depression when there is a parental divorce (Block et al., 1986; Cherlin et al., 1991; Sarigiani, 1990). Lastly, poor peer popularity has also been linked to depressive symptoms and depression (Jacobsen et al., 1983). There is evidence suggesting exercise improves areas of social functioning. For instance, results from a pilot study titled “Depressed Adolescents Treated with Exercise (DATE)” indicated improvements in relationships with parents and peers, based on the Children’s Global Assessment Scale and Child’s Family Global Assessment Scale (Shaffer et al., 1983), for adolescents in the vigorous exercise group in comparison to the controls (Hughes et al., 2013).

### **Purpose of the Study**

The purpose of the present study is to summarize and synthesize the research that pertains to the impact of aerobic exercise on adolescents with depression. Adolescents, rather than children, were specifically selected as the population to be examined for several reasons. First and foremost, rates of depression between children and adolescents are quite distinct. The prevalence of depression in children is less than 1% in most studies (Kessler et al., 2001), whereas 13.3% of United States adolescents (i.e., 3.2 million) have depression. Multiple theories attempt to account for this age difference, but the “most commonly postulated contributors are puberty and brain and cognitive maturation” (Thapar et al., 2012, p. 1,057). For example,

adolescents experience an increase in self-awareness, social understanding (Blakemore, 2008), and stress levels, as well as changes in brain circuitry responsible for reward and danger (Nelson et al., 2005; Silberg et al., 1999). Furthermore, 70.77% of adolescents with depression report severe impairment (NIMH, 2019). This impairment can have adverse effects on their livelihood, such as their academic, social, and family functioning (Guberman & Manassis, 2011; Lundy et al., 2010; Puig-Antich et al., 1993). Adolescents with depression are also at risk for developing depressive episodes in adulthood too (Kovacs, 1996). Given these statistics, it is imperative to examine depression in children separately from adolescents, as combining these two age groups together in a study of depression may lead to inappropriate and incorrect generalizations. That said, because the prevalence of depression is higher in adolescents and this age group experiences functional impairments secondary to their depression, adolescents are the focus of the present study.

In addition to the specificity of an age group, the particular type of exercise to be reviewed will be aerobic. Aerobic exercise is “any activity that uses large muscle groups, can be maintained continuously and is rhythmic in nature” (Patel et al., 2017, p. 135). Examples of aerobic exercise include, but not limited to, swimming, rowing, cycling, running, and walking (Kravitz, 2020). Aerobic exercise has the strongest evidence in the use as a treatment for depression in adolescents (Dunn & Weintraub, 2008). For instance, Stella et al. (2005) conducted a randomized controlled trial comparing a 12-week aerobic intervention to an anaerobic control with adolescents. Based on the BDI (Beck, 1961) scores, the results suggested that significant reductions in depressive symptoms were found in the aerobic group, but not in the anaerobic group. Aerobic exercise has also been documented to be effective amongst gender and minority racial and ethnic groups. To illustrate, Koniak-Griffin (1994) examined the efficacy of a 6-week

aerobic exercise program to a wait-list control for only adolescent females. Results from the CES-D (Radloff, 1977) indicated that the females who received the exercise treatment endorsed significant reductions in depressive symptoms when compared to the control group. MacMahon (1990) conducted a randomized control trial that examined the efficacy of a 12-week aerobic exercise intervention only among adolescent males. There were significant changes in depressive symptoms, based on the BDI (Beck, 1961), in the experimental group in comparison to the control male subjects. With regards to minority racial and ethnic groups, Hong et al. (2009) and Flynn et al. (2021) found exercise to be negatively associated with depression for Chinese and African Americans, respectively.

This review will address three general questions. Firstly, the effects of aerobic exercise on depressive symptoms in adolescents are typically analyzed at post-intervention and/or follow-up. Research indicates that there are reductions in depressive symptoms at either time interval (see Hilyer, 1982; Jeong, 2005). Thus, this review hopes to provide clinicians information about the time variable benefits of exercise for the adolescent population with depression. Two variables of time will be analyzed: short-term and long-term. For the purposes of the present dissertation, short- and long-term will be operationalized as post-intervention to 12-weeks and 13-weeks to 52-weeks, respectively.

Secondly, this review aims to determine which modality of aerobic exercise (i.e., exercise as psychotherapy or exercise as an adjunct to psychotherapy) leads to better outcomes in adolescents with depression. Without such knowledge, clinicians may be incorrectly using exercise in treatment. As such, this review may provide the requisite information for providers to refer their adolescent clients with depression to either an exercise program in lieu of psychological treatment or incorporate exercise as homework. It should be noted that exercise

during psychotherapy will be omitted. The literature documenting its efficacy remains in its infancy (i.e., there is only one published study; see Doucette, 2004).

Lastly, there are gender and racial and ethnic differences in the response of psychotherapy and anti-depressant medications (see Baker, 2003; Yang et al., 2011). Thus, it would seem reasonable to assume that aerobic exercise, as an intervention, may also have differing responses amongst genders and racial groups. Thus, this review will attempt to illuminate any contrasting aerobic exercise responses between adolescent gender and/or racial groups with depression. That way, clinicians may be either more inclined or disinclined to recommend aerobic exercise amongst their diverse clientele, dependent upon the client's gender and/or race.

### **Research Questions**

Research questions (RQ) for the proposed study involve the following:

- RQ 1. What are the short-term and long-term effects of aerobic exercise interventions on depressive symptoms in adolescents?
- RQ 2. Does aerobic exercise in lieu of psychotherapy or aerobic exercise as an adjunct to psychotherapy have better outcomes for depressive symptoms in adolescents?
- RQ 3. Do the effects of aerobic exercise on depression in adolescents vary with gender and race?

## Chapter 2: Methodology

### Introduction

The proposed systematic review evaluated the effects of exercise on adolescents with depression. It addressed the short- and long-term effects of exercise, methods of exercise (i.e., in lieu of psychotherapy and adjunct to psychotherapy), and variable effects of exercise between gender and race.

### Eligibility Criteria

The inclusion criteria were structured through the following approach: population, intervention, comparator, outcomes, and study design (PICOS; Methley et al., 2014). The inclusion criteria aided in determining whether a study will be included in the present review (see Appendix B).

### Inclusion Criteria

In accordance with the World Health Organization's definition of adolescence (2018), the mean or median age of the participants were 10- to 19-years-old. In addition, the participants had either (a) clinical diagnosis of a depressive disorder or (b) reported depressive symptoms at baseline from either a self-report measure of depression or clinician-administered measure of depression, which included a score that is above the clinical cut-off of that measure.

Included studies promoted or increased aerobic exercise either (a) in lieu of psychotherapy or (b) as an adjunct to an evidenced-based psychotherapy (e.g., CBT and IPT; see Weersing et al., 2017). The aerobic exercise program was defined as “any activity that uses large muscle groups, can be maintained continuously and is rhythmic in nature” (Patel et al., 2017, p. 135). Examples of aerobic exercise included, but not limited to, swimming, rowing, cycling, running, and walking (Kravitz, 2020).



Included studies incorporated at least one of the following comparison conditions: (a) no treatment, (b) treatment as usual, (c) waiting list, (d) psychosocial intervention, (e) education intervention, or (f) within-subject design.

Included studies incorporated at least one of the following valid and reliable methods for the assessment of depression: (a) clinician-administered measure of depression (e.g., CDRS-R; Poznanski et al., 1985); (b) self-report measure of depression (e.g., CES-D; Radloff, 1977); or (c) semi-structured diagnostic interview (e.g., SADS-PL; Lauth et al., 2010). The outcome measure(s) must be administered at baseline and post-intervention. Included studies must also include the sensitivity and specificity of the psychological measure of depression.

The included studies were quantitative and included any research design, published in a peer-reviewed journal with the date range of January 2010 to January 2020.

### **Exclusion Criteria**

The exclusion criteria included: (a) dual diagnoses (e.g., depression and anxiety); (b) combination studies (e.g., CBT combined with medication); (c) anaerobic or strength training exercise; (d) individual and team sports, (e) qualitative studies (i.e., the study does not incorporate a quantitative outcome measure of depression), and (f) follow-ups of 53-weeks or later.

### **Search, Screening, and Selection Strategy**

#### ***Information Sources***

The following databases were utilized in order to search for studies: Medline, PubMed, PsychARTICLES, PsychINFO, Francis & Taylor, and SPORTDiscus.

### ***Search Terms***

A broad and wide literature search used key terms, in addition to truncation, phrase searching, and parentheses, in order to conduct an effective examination in the bibliographic databases. These primary search terms included: “adolescent,” “aerobic exercise,” “depression,” “control group,” “experiment,” “benefits,” “psychotherapy,” “gender,” and “race/ethnicity.” These search terms had a unique identification number (e.g., adolescent will be one, exercise will be two, etc.) throughout the documentation, screening, and selection process. There were also synonym/alternate forms for each primary search term (see Appendix C).

The literature searches included, at the very least, the following primary terms and its synonym/alternate forms<sup>1</sup>: “adolescent” AND “aerobic exercise” AND “depression” AND “control group” AND “experiment.” Additional primary terms and their respective synonym/alternate forms were added to address one of three research questions, as shown below.

Research question one (i.e., short- and long-term effects) included: (“Adolescent” OR "adolescence" OR “youth” OR “teen” OR “puberty” OR “high school” OR “middle school” OR “tween” OR “student” OR “young adult\*” OR “emerging adult\*” OR “young person” OR “juvenile” OR “young people” OR “minor”) AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND (“Depress\*” OR “melancholia” OR “dysphoria” OR “dysthymia” OR “Beck Depression Inventory” OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children’s Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective

<sup>1</sup> For the purpose of space and duplication, the synonym/alternate forms were omitted in this section, all aforementioned forms can be located in Appendix D.

Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND ("Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education\* intervention" OR "psychosocial intervention" OR "within-subject design") AND ("Controlled trial" OR "random" OR "trial" OR "randomized clinical trial" OR "randomized control trial" OR "observational study" OR "observation" OR "quasi-experimental" OR "quasi-experimental study" OR "longitudinal" OR "longitudinal study" OR "cohort" OR "cohort study" OR "case-control" OR "case-control study" OR "cross-sectional" OR "cross-sectional study" OR "ecological" OR "ecological study" OR "within-subject" OR "within-subject design") AND ("post-intervention" OR "3 months" OR "3 months follow-up" OR "three months" OR "three months follow-up" OR "12 weeks" OR "12 weeks follow-up" OR "twelve weeks" OR "twelve weeks follow-up" OR "6 months" OR "6 months follow-up" OR "six months" OR "six months follow-up" OR "26 weeks" OR "26 weeks follow-up" OR "twenty-six weeks" OR "twenty-six weeks follow-up" OR "12 months" OR "12 months follow-up" OR "twelve months" OR "twelve months follow-up" OR "52 weeks" OR "52 weeks follow-up" OR "fifty-two weeks" OR "fifty-two weeks follow-up").

Research question two (i.e., in lieu of psychotherapy or adjunct to psychotherapy) contained: ("Adolescent" OR "adolescence" OR "youth" OR "teen" OR "puberty" OR "high school" OR "middle school" OR "tween" OR "student" OR "young adult\*" OR "emerging adult\*" OR "young person" OR "juvenile" OR "young people" OR "minor") AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND ("Depress\*" OR "melancholia" OR "dysphoria" OR "dysthymia" OR "Beck Depression Inventory" OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory"

OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND (“Control” OR “control group” OR “wait list” OR “no treatment” OR “treatment as usual” OR “as usual” OR “education\* intervention” OR “psychosocial intervention” OR "within-subject design") AND (“Controlled trial” OR “random” OR “trial” OR “randomized clinical trial” OR “randomized control trial” OR “observational study” OR “observation” OR “quasi-experimental” OR quasi-experimental study” OR “longitudinal” OR “longitudinal study” OR “cohort” OR “cohort study” OR “case-control” OR “case-control study” OR “cross-sectional” OR “cross-sectional study” OR “ecological” OR “ecological study” OR "within-subject" OR "within-subject design") AND ("in lieu of psychotherapy" OR "in lieu of talk therapy" OR "adjunct to psychotherapy" OR "adjunct to talk therapy" OR “evidenced-based psychotherapy” OR “evidenced-based therapy” OR "therapy" OR "treatment" OR "counseling" OR "interventions" OR "cognitive behavioral therapy" OR "CBT" OR "interpersonal therapy" OR "IPT").

Research question three (i.e., gender and race/ethnicity) consisted of: (“Adolescent” OR "adolescence" OR “youth” OR “teen” OR “puberty” OR “high school” OR “middle school” OR “tween” OR “student” OR “young adult\*” OR “emerging adult\*” OR “young person” OR “juvenile” OR “young people” OR “minor”) AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND (“Depress\*” OR “melancholia” OR “dysphoria” OR “dysthymia” OR “Beck Depression Inventory” OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent

Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND ("Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education\* intervention" OR "psychosocial intervention" OR "within-subject design") AND ("Controlled trial" OR "random" OR "trial" OR "randomized clinical trial" OR "randomized control trial" OR "observational study" OR "observation" OR "quasi-experimental" OR "quasi-experimental study" OR "longitudinal" OR "longitudinal study" OR "cohort" OR "cohort study" OR "case-control" OR "case-control study" OR "cross-sectional" OR "cross-sectional study" OR "ecological" OR "ecological study" OR "within-subject" OR "within-subject design") AND ("male" OR "female" OR "boy" OR "girl" OR "transgender" OR "gender variant" OR "gender conform\*" OR "gender nonconform\*") AND ("race" OR "racial group\*" OR "white" OR "black" OR "African American" OR "Asian" OR "American Indian" OR "Alaska Native" OR "Native Hawaiian" OR "Other Pacific Islander" OR "ethnicity" OR "hispanic" OR "non-hispanic white" OR "Native Americans" OR "Jewish" OR "Native Hawaiians" OR "Pacific Islander" OR "Puerto Ricans" OR "Russian" OR "Latinx" OR "Romanian" OR "Mexican" OR "Chinese" OR "Turkish" OR "Korean" OR "Irish" OR "Kurd" OR "Mongols" OR "Arabs" OR "Uzbek" OR "Indian" OR "British" OR "Palestinian" OR "Kazakhs" OR "Armenian" OR "Albanian" OR "Tibetan" OR "Vietnamese" OR "Pakistani" OR "Bangladeshi" OR "Welsh" OR "Scottish").

### ***Selection of Studies***

There were three separate searches for the three research questions (with their respective set of primary and synonym/alternate forms) in all of the aforementioned databases. A Microsoft

Excel<sup>2</sup> spreadsheet titled Search Plan (see Appendix D) outlined this process, which includes (a) search type, (b) databases or sources, (c) search term identification number, (d) search syntax or instructions, (e) fields to search, and (f) specifiers. For instance, the search terms listed for research question one (see Search terms) were inputted in Medline, PubMed, PsychARTICLES, PsychINFO, Francis & Taylor, and SPORTDiscus. Subsequently, all of the search terms listed for research question two were entered in the same databases, etc. That way, each research question was separately searched rather than combining all of the primary terms and synonym/alternate forms in one search for all of the databases.

The results from the literature search and selection of articles were deliberately documented via a Microsoft Excel spreadsheet titled Search Documentation (see Appendix E). It had columns that included (a) search date, (b) full search identification number, (c) type of search, (d) database/source, (e) search term identification number, (f) search syntax or other guidelines for the search, (g) fields searched, and (h) search specifier (e.g., years, publication type, etc.).

There were three phrases for the screening process. First, the resulted studies from the literature searches were screened by title, keywords, and abstract. Those studies that did not meet the inclusion criteria (e.g., adolescents, depression, and exercise) from the title, keywords, and abstract were excluded. Subsequently, a full-text review for the remaining studies commenced to determine if those studies met the inclusion criteria. Lastly, a final decision was made for each peer-reviewed article based upon whether or not it fully met the inclusion criteria.

A modified preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow chart was incorporated to record the quantity of: (a) initial studies, (b) included

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<sup>2</sup> Please note all Microsoft Excel spreadsheets were converted to Microsoft Word Tables for optimal viewing purposes.

and excluded studies post-screening, (c) eligible studies, and (d) included studies. It should be noted that the modified PRISMA flow chart did not include both “Additional records identified through other sources,” since electronic databases will be the only resource for the literature searches, and “Studies included on quantitative synthesis (meta-analysis),” given the present study was not a meta-analysis. Furthermore, the Included section was altered to state “Studies included in qualitative synthesis and quantitative descriptive summaries.”

## **Data Collection and Extraction**

### ***Data Collection and Coding***

The variables for data collection for adolescents with depression included: (a) short-term effects of exercise, (b) long-term effects of exercise, (c) exercise in lieu of psychotherapy, (d) exercise as an adjunct to psychotherapy, (e) effects of exercise in genders, and (f) effects of exercise in race. These variables addressed the aforementioned research questions.

### ***Development of the Data Extraction Form***

The lead author independently extracted the data from the eligible studies with a pilot-tested Data Extraction and Collection Form. Coded information included:

- general information (e.g., title of article),
- design characteristics and methodological features (e.g., treatment type),
- research variables (e.g., type of exercise, depression outcome using exercise),
- study participant characteristics (e.g., gender and race),
- setting characteristics (e.g., location),
- analysis (e.g., outcome findings),
- results (e.g., did the results vary with gender?), and
- conclusions and follow-up (e.g., recommendations)

### ***Data Extraction***

The obtained data from the Data Extraction and Collection form was inputted in a Microsoft Excel spreadsheet titled Evidence Table: Overview of Included Studies. In order to ensure consistency and accuracy of the data, two independent raters (i.e., lead author and research assistant) was involved in both the extraction and critical review by using the Individual Study Quality Appraisal forms.

### **Quality Appraisal**

Data from the selected articles was separately and critically assessed with an Individual Study Quality Assessment form. This form was intended to ensure that the collected data were valid and pertinent to the aforementioned research questions. First, the researcher wrote the author(s), year of publication, and study identification number. Second, the researcher selected the type of methodology the study employed (e.g., quantitative or mixed methods) and wrote the specific design/inquiry approach. The remaining areas were evaluated through a Likert scale, with the following ratings: *strong* = 3, *good/adequate* = 2, *weak* = 1, *missing* = 0, and *not available* (N/A). These areas included: (a) strength of literature foundation and rationale for study, (b) clarity and specificity of research aims, (c) quality of research design, (d) sample selection and characteristics, (e) measures, (f) data collection, (g) analysis of data, (h) discussion of study limitations, and (i) consideration of culture and diversity. Lastly, there was an overall rating for the study, which includes: *exemplary* (i.e., all 3's), *strong* (i.e., mostly 3's), *good/adequate* (i.e., mostly 2's), and *weak* (i.e., mostly 1's).



## **Data Management, Synthesis, and Analysis Plan**

### ***Database Development***

Data from the Data Extraction and Collection and Individual Study Quality Assessment forms were inputted and organized into a Microsoft Excel spreadsheet titled Evidence Table: Overview of Included Studies. Variables included in the Microsoft Excel spreadsheet were: short-term effects, long-term effects, exercise model (e.g., in lieu of psychotherapy or adjunct to psychotherapy), and sample characteristics (e.g., gender and race).

### ***Data Analysis and Synthesis***

The specific data analysis and synthesis method was a content analysis. The researcher analyzed the data in order to discern if there were any patterns that may be connected to the research questions. For example, evaluations of the data included: short- and long-term effects of exercise for adolescents with depression, differences in outcomes for depressive symptoms in adolescents between exercise in lieu of psychotherapy or exercise as an adjunct to psychotherapy, and variable effects of exercise on depression in adolescents between gender and race.

### ***Reporting of the Results***

The analysis and synthesis of the data was organized into four Microsoft Excel spreadsheets. The first spreadsheet was titled Evidence Table: Overview of Included Studies, which included the following columns: author(s), research methodology and design, sample characteristics (age), outcome variable assessed: short-term effects of exercise, outcome variable assessed: long-term effects of exercise, outcome variable assessed: exercise model, outcome variable assessed: genders of sample, outcome variable assessed: races of sample, effect size, pre-test, post-test, and results/main findings.

With regard to the remaining three spreadsheets, each specifically addressed the aforementioned research questions with specific data columns. The tables were labeled as Evidence Table - RQ 1, Evidence Table - RQ 2, and Evidence Table - RQ 3. For Evidence Table - RQ 1, columns included author(s), sample characteristics (age), outcome variable assessed: short-term effects of exercise, outcome variable assessed: long-term effects of exercise, effect size, pre-test, post-test, and results/main findings. For Evidence Table - RQ 2 columns included author(s), research methodology and design, sample characteristics (age), outcome variable assessed: treatment modality, effect size, pre-test, post-test, and results/main findings. For Evidence Table - RQ 3, columns included author(s), research methodology and design, sample characteristics (age), outcome variable assessed: genders of sample, outcome variable assessed: races of sample, effect size, pre-test, post-test, and results/main findings.

### Chapter 3: Results

The results of this systematic review present a current representation of the impact of exercise on adolescents with depression. First, there will be a broad discussion of the findings (e.g., search results) and overall final study inclusion. The remainder of the chapter will address the three research questions. Each of these sections will discuss the process of the systematic literature review (i.e., from the search results to included articles) and review the included articles with a specific emphasis on the research question posed within the section.

#### **Aerobic Exercise and Adolescent Depression**

##### ***Search Results***

The three literature searches produced a total of 2,122 articles. After duplicates were removed, 1,831 studies remained for review. The remaining articles were screened by (a) title, (b) keywords, and (c) abstract and subsequently excluded if they did not meet the inclusion criteria (e.g., adolescents, depression, and exercise), which resulted in a total of 77 articles. The lead author conducted a full-text review of the remaining articles in order to ensure the studies met the entirety of the inclusion criteria. Sixty-nine articles were excluded, which resulted in eight articles eligible for the present systematic review (see Appendix A). A PRISMA flow chart of the aforementioned process and Evidence Table of all included studies are available for review in Appendix F and Appendix G, respectively.

##### ***Study Characteristics***

Data from the included studies were extracted with pilot-tested Data Extraction and Collection forms. There were several findings based on the extracted data. For instance, the mean age of the adolescents was 15.04 years old with an age range of 12- to 18-years-old. All of the studies reported the gender of the adolescents, with an overwhelming majority being female

( $N = 256$ ; 72%). More than half of the studies (63%) reported the race and ethnicity of the adolescents; two studies included White British or Other and the remaining three studies used White, Hispanic, Latino, or Minority Race. Six (75%) studies within this systematic review were RCTs. Almost all of the studies ( $N = 7$ ; 88%) incorporated individual psychological interventions, with only one study using groups. The CDRS ( $N = 5$ ; Poznanski et al., 1979) was the most frequently used scale to assess depressive symptoms in adolescents, followed by the BDI-II ( $N = 3$ ; Beck et al., 1996) and K-SADS-PL ( $N = 3$ ; Lauth et al., 2010). All studies (100%) assessed depression at baseline and post-intervention, but only 63% ( $N = 5$ ) of the studies included a follow-up. All Data Extraction and Collection forms can be found in Appendix H (raw data not included).

### ***Methodological Quality of Studies***

The methodological strength of the included studies was assessed via Individual Study Quality Assessment forms. There were nine items, each were rated either as *Strong* = 3, *Good/Adequate* = 2, *Weak* = 1, *Missing* = 0, or *Not Available* (N/A). Each included study could range from 0 to 27 and the last item provided an Overall Rating of *Exemplary* (all 3's), *Strong* (mostly 3's), *Good/Adequate* (mostly 2's), and *Weak* (mostly 1's).

All of the studies ( $N = 8$ ; 100%) were *Strong* (i.e., 3's) in the following areas: (a) Strength of Literature Foundation and Rationale for Study; (b) Clarity and Specificity of Research Aims/Objectives/Questions; (c) Quality of Research Design or Methodological Approach; and (d) Data Collection. Out of the eight studies, seven (88%) articles also demonstrated a *Strong* (i.e., 3's) rating in (a) Measures/Data Collection Tools and (b) Analysis of Data. Discussion of Study Limitations was also mostly *Strong* ( $N = 5$ ; 63%). Conversely, lower ratings were found in (a) Sample Selection and (b) Consideration of Culture and Diversity. The

majority of the studies (88%) had an Overall Rating of *Strong* (i.e., mostly 3's). See Appendix I for the Individual Study Quality Assessment forms for all included studies (raw data not included).

### **Aerobic Exercise: Short- and Long-term Effects**

A literature search for the short- and long-term effects of aerobic exercise on adolescents with depression resulted in 608 articles. Once duplicates were removed, 525 records remained. Articles were subsequently screened by title, keywords, and abstract. Those that did not meet the inclusion criteria (e.g., adolescents, depression, and exercise) were excluded, which resulted in 25 articles. The remaining articles were assessed via a full-text review in order to evaluate if the author(s) assessed short- and long-term effects of aerobic exercise on adolescents with depression. Of this review, 22 articles were excluded, resulting in three studies. Articles were largely excluded based on the age of participants (i.e., adults), date of publication (i.e., before 2010), and lack of a valid and reliable depression outcome measure. With regards to the latter, those studies were excluded based on single item questions about a depression diagnosis (e.g., “I am depressed”). Please refer to Appendix J for the template utilized for the Screening and Selection process and Appendix K for the Evidence Table.

Of the studies that examined short-term effects, one study (33%) found acute antidepressant effects of aerobic exercise in adolescents. Radovic et al. (2017) examined how aerobic exercise may contribute to the reduction of depressive symptoms in adolescents. At post-intervention (i.e., 6-weeks), the “Freidman test demonstrated a significant difference in depressive symptoms as measured by the CDRS-R” (p. 143). With regards to long-term effects, two studies (66%) were associated with a decrease in depressive symptoms at follow-up. For instance, Carter et al. (2015) evaluated the effectiveness of aerobic exercise on the depressive

symptoms of 87 adolescents (ages 14 to 17). Based on the CDI-II, there was a statistically significant effect on the depressive symptoms at the 6-month follow-up. The authors noted that the treatment group scores were, on average, five points less than the treatment as usual group. In context, Carter et al. (2015) asserted that this may have implications for clinical practice, given that the CDI-II has a cut off of 14 points for clinical symptoms of depression. Comparably, Jelalian et al. (2019) found the depressive scores declined on the BDI-II, CDRS, and K-SADS-PL at a follow-up (i.e., 48-weeks). More specifically, reported depressive symptoms at baseline and 12-month follow-up indicated a significant decline from moderate to minimal symptoms of depressed mood, respectively.

### **Aerobic Exercise: In Lieu of and as an Adjunct to Psychotherapy**

The systematic literature search for aerobic exercise (a) in lieu of psychotherapy and (b) as an adjunct to psychotherapy resulted in 908 articles. Duplicates were removed and 834 articles remained. The existing articles were screened by title, keywords, and abstract. Those that did not meet the inclusion criteria (e.g., adolescents, depression, and exercise) were excluded. 46 articles were eligible for a full-text review. After carefully evaluating these articles, specifically if the author(s) compared aerobic exercise in lieu of or as an adjunct to psychotherapy, only four articles remained. Articles were excluded mainly due to age of participants (e.g., younger than 11-years-old), publication out of date range (e.g., before 2010), and not including a valid and reliable depression measure (e.g., single item questions about a depression diagnosis). Appendix L provides the template utilized for the Screening and Selection process and Appendix M details the included studies, respectively.

Three studies (75%) evaluated the impact of aerobic exercise as an adjunct to psychotherapy, all of which found significant reductions in depressive symptoms. For example,

Jelalian et al. (2019) evaluated the effects of a CBT protocol and exercise regimen for adolescents with depression. Based on the BDI-II, CDRS, and K-SADS-P, their results suggested depressive symptoms decreased at post-intervention and follow-up (i.e., 24-weeks). Similarly, Radovic et al. (2017) evaluated how exercise, as an adjunct to psychological interventions, may ameliorate depressive symptoms in adolescents. Results from the CDRS-R indicated that depressive symptoms significantly decreased from the pre- to post-intervention. Lastly, Fidelix et al. (2019) examined the effects of aerobic exercise and psychological counseling on depression in adolescents. Based on the BDI, the adolescents reported a decrease in their depressive symptoms at post-intervention.

Only one study (25%) examined aerobic exercise in lieu of psychotherapy. Carter et al. (2015) evaluated a 12-week trial of the effects of aerobic exercise versus psychological therapies on adolescents with depression. Details pertaining to the psychological therapy (e.g., theoretical orientation, individual or group, etc.) were not disclosed. The results, based on the CDI-2, indicated that the aerobic exercise and psychological therapy group did not differ at post-intervention. But at the 6-month follow-up, there was a significant decrease in depressive symptoms for the aerobic exercise group by five points on the CDI-2, which, according to the authors, is particularly significant when considering the cut off for clinical depression this measure is fourteen.

### **Aerobic Exercise: Gender and Race/Ethnicity**

A literature search was conducted in order to investigate gender and racial and ethnic differences in the antidepressant effect of exercise on adolescents. Of which, a total of 534 results emerged from the databases. There were 472 remaining articles once the duplicates were removed. The remaining articles were screened via title, keywords, and abstract. After excluding

articles based on inclusion criteria, six remaining articles were eligible for a full-text review. However, only one article met all of the inclusion criteria, specifically with regards to the gender and race of the study participants. Articles were excluded based on different forms of exercise (e.g., anaerobic), age of participants (i.e., adults), and publication date (i.e., before 2010). The Screening and Selection templated table and chart documenting the article's pertinent information can be found in Appendix N and Appendix O, respectively.

The only study that met all inclusion criteria was titled “Cognitive-Behavioral Therapy Plus Healthy Lifestyle Enhancement for Depressed, Overweight/Obese Adolescents: Results of a Pilot Trial.” Jelalian et al. (2019) evaluated the efficacy of a CBT protocol in conjunction with an aerobic exercise regimen in an urban/suburban community in the northeast of the United States. Adolescents were randomized into the CBT ( $N = 9$ ) or CBT Healthy Living (CBT-HL;  $N = 24$ ) group. The CBT group only received a CBT protocol, primarily based on prior trials with adolescents with depression (March et al., 2004). Conversely, adolescents in the CBT-HL group received the same CBT protocol, in addition to weekly, 60-minute aerobic exercise. There were seven females and two males and 17 females and seven males in the CBT and CBT-HL group, respectively. The authors only included two types of ethnicities: “Latino” and “Minority Race” (p. S28). Of which, there were three Latinos and six Minority Race adolescents in the CBT group, and eight Latino and 18 Minority Race subjects in the CBT-HL group. Based on the BDI scores, there were significant reductions in depressive symptoms between the CBT and CBT-HL. However, the authors did not compare the outcome results between either genders or race of the participants. Jelalian et al. (2019) only provided the sociodemographic characteristics of the sample.



## Summary

The results of the systematic review of the literature suggested several preliminary conclusions. In terms of the short- and long-term effects of aerobic exercise on depression in adolescents, the results indicated that aerobic exercise may produce both acute and delayed effects. Concerning aerobic exercise in lieu of psychotherapy and aerobic exercise as an adjunct to psychotherapy, the studies greatly varied. No study exclusively examined difference in outcomes between the two ways in which aerobic exercise may be incorporated for adolescents with depression. In light of this, it appeared that aerobic exercise as an adjunct to psychotherapy contributes to a decrease in depression in this population. But, this finding should be interpreted with caution as the study had a small sample size (i.e.,  $N = 10$ ). Lastly, only one study met the full inclusion criteria to examine gender and racial differences in the treatment of depression in adolescents. However, this study only provided minimal sociodemographic variables of the study participants. Of which, the outcomes between gender and race were not compared with one another. Thus, it remains unclear at this time of any similarities and/or differences.

## Chapter 4: Discussion

The purpose of the present study was to summarize and synthesize the research regarding the impact of aerobic exercise on adolescents with depression. More specifically, it evaluated peer-reviewed studies in order to address the following questions:

- What are the short-term and long-term effects of aerobic exercise interventions on depressive symptoms in adolescents?
- Does aerobic exercise in lieu of psychotherapy or aerobic exercise as an adjunct to psychotherapy have better outcomes for depressive symptoms in adolescents?
- Do the effects of aerobic exercise on depression in adolescents vary with gender and race?

The search results produced a total of 2,122 articles. Of which, eight articles were eligible for the present systematic review. The literature search for the short- and long-term effects resulted in three articles. The studies suggested that the aerobic exercise treatment groups had both an acute (i.e., 6-weeks) and delayed (i.e., 24- and 48-weeks) effect on depressive symptoms. Concerning aerobic exercise and psychotherapy, four articles met all inclusion criteria. These studies indicated that the aerobic exercise (a) as an adjunct to psychotherapy and (b) in lieu of psychotherapy treatment modalities were effective in decreasing depressive symptoms. However, the latter modality was only significant at a 6-month follow-up. The gender and race/ethnicity search produced only one article. Of which, the authors did not compare the depression outcome results between either the gender or ethnicity/race of the subjects. Thus, it is difficult to discern if aerobic exercise on depressive symptoms in adults vary between sociodemographic variables.

### **Aerobic Exercise: Short- and Long-term Effects**

The included studies indicated that aerobic exercise is associated with both short- and long-term reductions in depressive symptoms in adolescents. However, this finding should be interpreted with caution. There were only three articles that met all inclusion criteria. Of which, only one and two were examined for the short- and long-term effects, respectively. Thus, this small sample size may “prevent the findings from being extrapolated” (Faber & Fonseca, 2014, p. 27). Despite such limitations, these findings are consistent with the research. Studies have reported associations with aerobic exercise and reductions in depressive symptoms in adolescents in as little as 6-weeks (see Beffert, 1994; Koniak-Griffin, 1994; Roshan et al., 2011) and 12-weeks (see Dopp, 2012; Hughes et al., 2013). There are also studies that show a similar correlation at 20-weeks (see Hilyer et al., 1982), 24-weeks (see Melynk et al., 2013), and up to 48-weeks (Jelalian et al., 2019).

Other treatments for adolescents with depressive symptoms indicated similar results too. Short- and long-term psychotherapy have been shown to be efficacious for this population; this includes, but not limited to, 12-week CBT (Birmaher et al., 2000), 12-week IPT (Mufson et al., 1999), 24-week IPT (Young, Mufson, & Gallop, 2010), and 52-week group and individual IPT (Spence & Donovan, 2014). Psychopharmacological studies also suggested short- and long-term effects for the reduction of depressive symptoms in adolescents. Acute effects (i.e., less than 4 weeks) have been found in fluoxetine (see Cipriani et al., 2016) and continued use (i.e., maintenance treatment; more than 24 weeks) of sertraline is not only tolerated and safe, but also efficacious for adolescents with depression (Rynn et al., 2006).

Although there is not an exact biological and/or physiological mechanism to explain the antidepressant effect of exercise, several hypotheses have been proposed. The monoamine

hypothesis asserts that exercise immediately increases the availability of neurotransmitters (e.g., norepinephrine, dopamine, and serotonin), which are typically decreased in an individual with depression (Craft & Perna, 2004). However, these studies have only been conducted on animals and yet to be confirmed in humans. This is due in part to the fact that it would be an invasive procedure to obtain such samples (e.g., spinal tap). The thermogenic hypothesis “suggests that a rise in core body temperature following exercise is responsible for the reduction in symptoms of depression” (Craft & Perna, 2004, p. 110). That is to say, when there is an increase in temperature in specific brain regions (e.g., brain stem), an individual may experience a sense of relaxation and, in turn, decrease in depressive symptoms (Craft & Perna, 2004). Lastly, the endorphin hypothesis asserts that there is a positive correlation between exercise and endorphins, with the latter being associated with positive mood. This finding has been found in both acute and chronic exercise (Bortz et al., 1981; Carr et al., 1981; Farrell et al., 1982).

Long-term effects of aerobic exercise may be a result of self-efficacy (Bridle et al., 2012). “Self-efficacy refers to the belief that one possesses the necessary skills to complete a task as well as the confidence that the task can actually be completed with the desired outcome obtained” (Craft & Perna, 2004, p. 110). As such, those who chronically exercise may become more confident in their abilities and, in turn, may feel more in control of their lives, especially when it comes to emotional or cognitive difficulties such as depression.

### **Aerobic Exercise: In Lieu of and as an Adjunct to Psychotherapy**

There were contrasting results between aerobic exercise (a) in lieu of psychotherapy and (b) as an adjunct to psychotherapy. With regards to aerobic exercise in lieu of psychotherapy, there was only one study that met all inclusion criteria. Of which, neither the aerobic exercise nor psychological therapy group differed at post-intervention, based on the results of the CDI-2. This

is of interest - given that there are several studies that evaluated this specific type of treatment modality and found aerobic exercise to be effective when used in lieu of psychotherapy.

Reductions in depressive symptoms amongst adolescents has been documented when this population was exposed to running and biking (Dopp et al., 2012), swimming (Roshan et al., 2011), and dance (Jeong et al., 2005).

The literature search for aerobic exercise as an adjunct to psychotherapy resulted in three studies. All of these studies suggested that this treatment modality was associated with reductions in depressive symptoms in adolescents. However, this small sample size is of concern, particularly since “very small samples undermine the internal and external validity of a study” (Faber & Fonseca, 2014, p. 29). In light of this, these findings are consistent with the research. For instance, reductions in depressive symptoms in adolescents with depression have been seen in behavioral reinforcement psychotherapy and aerobic exercise (Hilyer et al., 1982) and cognitive theory and aerobic exercise (Melnyk et al., 2013).

While it appears that both treatment modalities demonstrated positive results, the adjunct to psychotherapy has the most support. This may be due in part that combination studies (i.e., psychotherapy and psychopharmacology) have been shown to be superior to monotherapy. For instance, two large RCTs (Brent et al., 2008; March et al., 2004) provided “support for the superior efficacy of the combination SSRI medication plus CBT for adolescents with moderately severe depression and in those who had not improved on SSRI monotherapy” (Vitiello et al., 2011, p. 280). Reasoning behind this revolves around each modality’s mechanism of action. That is, while the medication dissipates the physical symptoms of depression, psychotherapy helps patients develop skills to cope with unfavorable emotions (National Institute of Health, 2007). With regards to aerobic exercise as an adjunct to psychotherapy, patients may experience both

increases in plasma endorphins (secondary to either acute or chronic aerobic exercise; Craft & Perna, 2004) and learn to cope with cognitive, emotional, and/or behavioral difficulties in a constructive manner. Consequently, the combination treatment may be more effective than either alone. Or, as Leer (1980) put it, exercise should be a “complementary measure” (p. 24) to psychotherapy, rather than an alternative.

### **Aerobic Exercise: Gender and Race/Ethnicity**

The literature search for variability between gender and race/ethnicity for the use of aerobic exercise for adolescents with depression was quite limited. Only one study met all inclusion criteria. Of which, only the sociodemographic characteristics of the sample were provided, which included two genders (i.e., male and female) and two ethnicities (i.e., Latino and Minority Race). But, the authors did not compare the results between these genders and races/ethnicities. This may not be surprising, given that no study has specifically examined gender and ethnic/racial differences of aerobic exercise in adolescents with depression, not to mention in psychotherapy or psychopharmacology. In light of this, gender differences do exist between male and female genders, with the latter twice as likely as men to be diagnosed with depression (Mayo Clinic, 2019). Possible explanations include, but not limited to, puberty, premenstrual problems, pregnancy, postpartum depression, perimenopause and menopause, and life circumstances and culture (e.g., unequal power and status). In order to address such disparity, surveys have been conducted in order to evaluate gender differences in exercise preferences as a treatment for depression. For instance, Busch et al. (2016) found that men preferred weightlifting slightly more than women and women preferred yoga much more than men. With this in mind, future studies may want to evaluate if there are differences in outcomes

of depression between adolescent boys and weightlifting versus adolescent girls and yoga, given the higher prevalence of developing depression in the latter gender.

### **Contributions**

The present review aimed to further inform clinicians, and the public, about the negative correlation between exercise and depression in adolescents. More specifically, it was a comprehensive review that provided information about the short- and long-term effects of exercise for depression in adolescents. It also discerned the effects of exercise as it pertains to psychotherapy. That is, whether incorporating exercise as an adjunct or in lieu of psychotherapy demonstrated more positive outcomes for adolescents with depression. Lastly, it provided the lack of research about how genders and races of adolescents vary with the use of exercise for their depressive symptoms.

Based on the results, it appears that aerobic exercise is effective for adolescents with depression. More specifically, aerobic exercise can be incorporated in the short- and long-term for depression. Aerobic exercise can also be used as an adjunct to psychotherapy. There are some delayed effects for aerobic exercise in lieu of psychotherapy. Lastly, it remains unclear if aerobic exercise has variable effects between genders and races/ethnicities.

Practically, it seems reasonable to suggest that aerobic exercise may be beneficial for clinicians to incorporate into treatment. For those who are either unclear and/or uncertain about the potential effects of aerobic exercise, the literature suggests that it not only has acute and delayed effects, but also can be incorporated as an additional modality to the psychological treatment. Moreover, the aerobic exercise can be continued post-treatment as a means to possibly protect against further depressive episodes (Harvard Gazette, 2019).

## Limitations

Given the scope of the present systematic review, limitations are inevitable. First and foremost, the age of the included studies' participants was specifically within the adolescent range (i.e., ages 10 to 19). Consequently, children, adults, and older adults, all of which have been associated with a positive impact on their depressive symptoms through exercise (DiLorenzo et al., 1999; López-Torres Hidalgo, 2019; Tziamali & Simons, 2008), were excluded from the study. Second, this review only investigated aerobic exercise, which includes, but not limited to, walking, running, cycling, rowing, and swimming. There are other physical activities that have been associated with a decrease in depressive symptoms, such as yoga (Bridges & Sharma, 2017) and team sports (Gorham et al., 2019), but they were excluded from the review. Third, an emphasis was placed on quantitative psychological assessments. However, psychological measurements have limitations and shortcomings, such as psychometric properties (e.g., reliability and validity) and “examinees may not respond honestly and accurately” (Tinsley & Rosen, 2001, p. 3). Adolescents may respond in a way in which they believe is socially desirable (e.g., decrease in depressive symptoms), rather than be sincere with their symptoms. As such, the reliability of such psychodiagnostic tests for adolescents with depression may not be an accurate tool to assess depression. Lastly, the diagnosis of the present review was quite specific, that is, depressive disorders. Thus, a variety of other mental disorders were not investigated, such as anxiety and posttraumatic stress disorder, despite documentation indicating a positive impact of exercise on symptoms of the previously mental disorders (Anderson & Shivakumar, 2013; Hegberg et al., 2019).



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## APPENDIX A

### Overview of Included Studies

Author(s)	Year	Research Methodology and Design	Sample Characteristics	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0) CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5) CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6) CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."
Carter, Guo, Turner, Morris, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"No effect on depressive symptoms was found at post-intervention" (i.e., 6 weeks).	"A statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention"	"Experimental group received "a six week circuit-training consisting of 12 separate sessions which were run twice weekly"  "The term TAU typically refers to a wide range of standard treatments available to the specific group in question. In this instance, TAU included psychological therapies...no participants reporting exercise as part of their usual treatment."  "No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."	33 female, 11 males; assessment of depression outcome measures were not assessed between genders	84 white, 3 other (not stated); assessment of depression outcome measures were not assessed between races	$d = 0.50$	CDI-2 $\alpha = 0.91$  6 weeks Intervention -5.21 (-8.29, -2.14) TAU -2.64 (-5.92, 0.63)	CDI-2  6 months Intervention -8.63 (-12.15, -5.12) TAU -3.82 (-7.53, -0.12)	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."
Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	"Depressive symptoms as measured by the CDRS-R were found...to significantly reduce from pre- to postintervention"	It was only a 6-week study	The authors noted that "As participants were receiving a form of treatment [i.e., psychotherapy] throughout both the baseline and intervention period, these results indicate that the addition of exercise to standard treatments for depression may have contributed to	7 females, 3 males	Unavailable	$z(N = 9) = -2.67, p = .008, r^2 = .40$	CDRS-R $\alpha = .83-.88$ 66.90(11.62) RADS-2 $\alpha = .91-.94$ 86.50(20.87)	CDRS-R 47.00(9.10) RADS-2 66.89(18.25)	A moderate significant reduction in depressive symptoms was found at postintervention

Author(s)	Year	Research Methodology and Design	Sample Characteristics <i>(n=100)</i>	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0) CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5) CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6) CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."
Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	"Depressive symptoms as measured by the CDRS-R were found...to significantly reduce from pre- to postintervention"	It was only a 6-week study	The authors noted that "As participants were receiving a form of treatment [i.e. psychotherapy] throughout both the baseline and intervention period, these results indicate that the addition of exercise to standard treatments for depression may have contributed to further reduction in depressive symptoms."	7 females, 3 males	Unavailable	$z (N = 9) = -2.67, p = .008, r^2 = .40$	CDRS-R $\alpha = .83-.88$ 66.90(11.62)  RADS-2 $\alpha = .91-.94$ 86.50(20.87)	CDRS-R 47.00(9.10) RADS-2 66.89(18.25)	A moderate significant reduction in depressive symptoms was found at postintervention
Carter, Guo, Turner, Morris, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"No effect on depressive symptoms was found at post-intervention" (i.e., 6 weeks).	"A statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention"	"Experimental group received "a six week circuit-training consisting of 12 separate session which were run twice weekly"  "The term TAU typically refers to a wide range of standard treatments available to the specific group in question. In this instance, TAU included psychological therapies...no participants reporting exercise as part of their usual treatment."  "No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive	33 female, 11 males; assessment of depression outcome measures were not assessed between genders	84 white, 3 other (not stated); assessment of depression outcome measures were not assessed between races	$d = 0.50$	CDI-2 $\alpha = 0.91$  6 weeks Intervention -5.21 (-8.29, -2.14) TAU -2.64 (-5.92, 0.63)	CDI-2  6 months Intervention -8.63 (-12.15, -5.12) TAU -3.82 (-7.53, -0.12)	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."

Author(s)	Year	Research Methodology and Design	Sample Characteristics <small>(n=)</small>	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Fidelix, Lofrano-Prado, Fortes, Hill, Caldwell, Botero, and Prado	2019	Quantitative, RCT	13-18	None (only assessed at baseline and 24 weeks)	Beck Depression Inventory scores decreased significantly in both groups ( $P \leq .01$ ) with higher ES observed for HIG ( $d = 1.16$ ; ES: large) compared with LIG ( $d = 0.45$ ; ES: small).	24 weeks of supervised aerobic training on treadmills. Those in the [high intensity group] HIG exercised at an intensity corresponding to individual ventilatory threshold 1 (VT1), whereas those in the [low intensity group] LIG exercised at a speed 20% below the VT1.  "Psychological counseling was conducted for 1 hour each week in small groups ( $n=9$ adolescents/group, mixed in terms of HIG or LIG) by a clinical psychologist. In addition, targeting psychological motivation for compliance, session themes related to body image, eating disorders (symptoms and consequences), the relationship between food and feelings, family and social problems, strategies to enhance mood and combat depression were discussed with the adolescents."	N/A	N/A	"the effect size (ES) for each intervention was calculated as proposed by Cohen (d)."  BDI $\alpha = .89$ HIG 19.86(7.75) LIG 18.86(8.44)	BDI HIG 12.29(5.69) LIG 14.85(10.14)	The results from the present study demonstrate that supervised exercise in a multi-dimensional intervention has positive effects on symptoms of depression.	
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$  BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0) CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5)  CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6)  CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	



## REFERENCES

- Carter, T., Guo, B., Turner, D., Morres, I., Khalil, E., Brighton, E., Armstrong, M., & Callaghan, P. (2015). Preferred intensity exercise for adolescents receiving treatment for depression: A pragmatic randomised controlled trial. *BMC Psychiatry, 15*, 247.  
<https://doi.org/10.1186/s12888-015-0638-z>
- Fidelix, Y., Lofrano-Prado, M. C., Fortes, L. S., Hill, J. O., Caldwell, A. E., Botero, J. P., & do Prado, W. L. (2019). Aerobic training performed at ventilatory threshold improves psychological outcomes in adolescents with obesity. *Journal of Physical Activity & Health, 16*(10), 851–856. <https://doi.org/10.1123/jpah.2018-0193>
- Jelalian, E., Jandasek, B., Wolff, J. C., Seaboyer, L. M., Jones, R. N., & Spirito, A. (2019). Cognitive-behavioral therapy plus healthy lifestyle enhancement for depressed, overweight/obese adolescents: Results of a pilot trial. *Journal of Clinical Child and Adolescent Psychology, 48*(1), S24–S33. <https://doi.org/10.1080/15374416.2016.1163705>
- Radovic, S., Gordon, M., & Melvin, G. (2017). Exercise as an adjunct in the treatment of adolescent depression. *Evidence-Based Practice in Child and Adolescent Mental Health, 2*(3-4), 139-149.

APPENDIX B

Worksheet for Developing Eligibility Criteria

### Research Questions

Research Question 1: What are the short-term and long-term effects of aerobic exercise interventions on depressive symptoms in adolescents?

Research Question 2: Does aerobic exercise in lieu of psychotherapy or aerobic exercise as an adjunct to psychotherapy have better outcomes for depressive symptoms in adolescents?

Research Question 3: Do the effects of aerobic exercise on depression in adolescents vary with gender and race?

### Source Eligibility Criteria

#### Population.

- Mean or median age of participants are 10- to 19-years-old
- Clinical diagnosis of a depressive disorder or reported and significant depressive symptoms

#### Intervention.

- Exercise as either in lieu of psychotherapy or as an adjunct to psychotherapy

#### Comparator.

- Incorporate a comparison condition (e.g., treatment as usual)

#### Outcomes.

- Assessment of depression with either clinician-administered, self-report, or semi-structured diagnostic interview

#### Study design.

- Quantitative and qualitative studies in a peer-reviewed journal
- In the English language and United States of America
- In the date range of January 2010 to January 2020

### Source Exclusion Criteria

- Dual diagnoses (e.g., depression and anxiety)
- Combination studies (e.g., CBT combined with medication)
- Anaerobic or strength training exercise
- Individual and team sports
- Qualitative studies
- Follow-ups of 53-weeks or later

APPENDIX C

List of Search Terms

<b>Search Term ID#</b>	<b>Primary Term</b>	<b>Synonyms/Alternate Forms</b>
1	Adolescent	"Adolescent" OR "adolescence" OR "youth" OR "teen" OR "puberty" OR "high school" OR "middle school" OR "tween" OR "student" OR "young adult*" OR "emerging adult*" OR "young person" OR "juvenile" OR "young people" OR "minor"
2	Aerobic Exercise	"aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups"
3	Depression	Depress*" OR "melancholia" OR "dysphoria" OR "dysthymia" OR "Beck Depression Inventory" OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL"
4	Control Group	"Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education* intervention" OR "psychosocial intervention" OR "within-subject design"
5	Experiment	"Controlled trial" OR "random" OR "trial" OR "randomized clinical trial" OR "randomized control trial" OR "observational study" OR "observation" OR "quasi-experimental" OR "quasi-experimental study" OR "longitudinal" OR "longitudinal study" OR "cohort" OR "cohort study" OR "case-control" OR "case-control study" OR "cross-sectional" OR "cross-sectional study" OR "ecological" OR "ecological study" OR "within-subject" OR "within-subject design"
6	Benefits	"post-intervention" OR "3 months" OR "3 months follow-up" OR "three months" OR "three months follow-up" OR "12 weeks" OR "12 weeks follow-up" OR "twelve weeks" OR "twelve weeks follow-up" OR "6 months" OR "6 months follow-up" OR "six months" OR "six months follow-up" OR "26 weeks" OR "26 weeks follow-up" OR "twenty-six weeks" OR "twenty-six weeks follow-up" OR "12 months" OR "12 months follow-up" OR "twelve months" OR "twelve months follow-up" OR "52 weeks" OR "52 weeks follow-up" OR "fifty-two weeks" OR "fifty-two weeks follow-up"
7	Psychotherapy	"in lieu of psychotherapy" OR "in lieu of talk therapy" OR "adjunct to psychotherapy" OR "adjunct to talk therapy" OR "evidenced-based psychotherapy" OR "evidenced-

<b>Search Term ID#</b>	<b>Primary Term</b>	<b>Synonyms/Alternate Forms</b>
		based therapy” OR "therapy" OR "treatment" OR "counseling" OR "interventions" OR "cognitive behavioral therapy" OR "CBT" OR "interpersonal therapy" OR "IPT"
8	Gender	“male” OR “female” OR “boy” OR “girl” OR “transgender" OR "gender variant” OR “gender conform*” OR “gender nonconform*”
9	Race/Ethnicity	“race” OR “racial group*” OR "white" OR "black" OR "African American" OR "Asian" OR "American Indian" OR "Alaska Native" OR "Native Hawaiian" OR "Other Pacific Islander" OR "ethnicity" OR "hispanic" OR "non-hispanic white" OR "Native Americans" OR "Jewish" OR "Native Hawaiians" OR "Pacific Islander" OR "Puerto Ricans" OR "Russian" OR "Latinx" OR "Romanian" OR "Mexican" OR "Chinese" OR "Turkish" OR "Korean" OR "Irish" OR "Kurd" OR "Mongols" OR "Arabs" OR "Uzbek" OR "Indian" OR "British" OR "Palestinian" OR "Kazakhs" OR "Armenian" OR "Albanian" OR "Tibetan" OR Vietnamese" OR "Pakistani" OR "Bangladeshi" OR "Welsh" OR "Scottish"

APPENDIX D

Search Plan

<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
Electronic database	Medline, PubMed, PsychARTICLES, PsychINFO, Francis and Taylor, and SPORTDiscus	1,2,3,4,5,6	("Adolescent" OR "adolescence" OR "youth" OR "teen" OR "puberty" OR "high school" OR "middle school" OR "tween" OR "student" OR "young adult*" OR "emerging adult*" OR "young person" OR "juvenile" OR "young people" OR "minor") AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND ("Depress*" OR "melancholia" OR "dysphoria" OR "dysthymia" OR "Beck Depression Inventory" OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND ("Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education* intervention" OR "psychosocial intervention" OR "within-subject design") AND ("Controlled trial" OR "random" OR	Title, keywords, abstract	Years: 2010-2020 Type: peer - reviewed articles only



<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
			<p>“trial” OR “randomized clinical trial” OR “randomized control trial” OR “observational study” OR “observation” OR “quasi-experimental” OR quasi-experimental study” OR “longitudinal” OR “longitudinal study” OR “cohort” OR “cohort study” OR “case-control” OR “case-control study” OR “cross-sectional” OR “cross-sectional study” OR “ecological” OR “ecological study” OR "within-subject" OR "within-subject design") AND ("post-intervention" OR "3 months" OR "3 months follow-up" OR "three months" OR "three months follow-up" OR "12 weeks" OR "12 weeks follow-up" OR "twelve weeks" OR "twelve weeks follow-up" OR "6 months" OR "6 months follow-up" OR "six months" OR "six months follow-up" OR "26 weeks" OR "26 weeks follow-up" OR "twenty-six weeks" OR "twenty-six weeks follow-up" OR "12 months" OR "12 months follow-up" OR "twelve months" OR "twelve months follow-up" OR "52 weeks" OR "52 weeks follow-up" OR "fifty-two weeks" OR "fifty-two weeks follow-up").</p>		
Electronic database	Medline, PubMed, PsychARTICLES, PsychINFO, Francis and	1,2,3,4,5,7	<p>(“Adolescent” OR "adolescence" OR “youth” OR “teen” OR “puberty” OR “high school” OR “middle school” OR “tween” OR “student” OR “young adult*” OR “emerging adult*” OR “young person” OR “juvenile” OR “young people” OR “minor”)</p>	Title, keywords, abstract	Years: 2010-2020 Type: peer - reviewed articles only

<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
	Taylor, and SPORTDiscus		<p>AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND ("Depress*" OR "melancholia" OR "dysphoria" OR "dysthymia" OR "Beck Depression Inventory" OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND ("Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education* intervention" OR "psychosocial intervention" OR "within-subject design") AND ("Controlled trial" OR "random" OR "trial" OR "randomized clinical trial" OR "randomized control trial" OR "observational study" OR "observation" OR "quasi-experimental" OR quasi-experimental study" OR "longitudinal" OR "longitudinal study" OR "cohort" OR "cohort study" OR "case-control" OR</p>		

<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
			<p>“case-control study” OR “cross-sectional” OR “cross-sectional study” OR “ecological” OR “ecological study” OR "within-subject" OR "within-subject design") AND ("in lieu of psychotherapy" OR "in lieu of talk therapy" OR "adjunct to psychotherapy" OR "adjunct to talk therapy" OR “evidenced-based psychotherapy” OR “evidenced-based therapy” OR "therapy" OR "treatment" OR "counseling" OR "interventions" OR "cognitive behavioral therapy" OR "CBT" OR "interpersonal therapy" OR "IPT").</p>		
Electronic database	Medline, PubMed, PsychARTICLES, PsychINFO, Francis & Taylor, and SPORTDiscus	1,2,3,4,5,8,9	<p>(“Adolescent” OR "adolescence" OR “youth” OR “teen” OR “puberty” OR “high school” OR “middle school” OR “tween” OR “student” OR “young adult*” OR “emerging adult*” OR “young person” OR “juvenile” OR “young people” OR “minor”) AND ("aerobic" OR "aerobic exercise" OR "aerobic fitness" OR "cardio" OR "cardiovascular fitness" OR "rhythmic" OR "large muscle groups") AND (“Depress*” OR “melancholia” OR “dysphoria” OR “dysthymia” OR “Beck Depression Inventory” OR "BDI" OR "BDI-II" OR "Center for Epidemiological Studies-Depression Scale" OR "CES-D" OR "Children's Depression Inventory" OR "CDI" OR "Reynolds Adolescent Depression Scale" OR "RADS" OR "RADS-2" OR "Hamilton Rating Scale for</p>	Title, keywords, abstract	Years: 2010-2020 Type: peer-reviewed articles only

<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
			<p>Depression" OR "Children's Depression Rating Scale-Revised" OR "CDRS-R" OR "Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime" OR "SADS-PL") AND ("Control" OR "control group" OR "wait list" OR "no treatment" OR "treatment as usual" OR "as usual" OR "education* intervention" OR "psychosocial intervention" OR "within-subject design") AND ("Controlled trial" OR "random" OR "trial" OR "randomized clinical trial" OR "randomized control trial" OR "observational study" OR "observation" OR "quasi-experimental" OR quasi-experimental study" OR "longitudinal" OR "longitudinal study" OR "cohort" OR "cohort study" OR "case-control" OR "case-control study" OR "cross-sectional" OR "cross-sectional study" OR "ecological" OR "ecological study" OR "within-subject" OR "within-subject design") AND ("male" OR "female" OR "boy" OR "girl" OR "transgender" OR "gender variant" OR "gender conform*" OR "gender nonconform*") AND ("race" OR "racial group*" OR "white" OR "black" OR "African American" OR "Asian" OR "American Indian" OR "Alaska Native" OR "Native Hawaiian" OR "Other Pacific Islander" OR "ethnicity" OR "hispanic" OR</p>		

<u>Search Type</u>	<u>Databases or Sources</u>	<u>Search Term ID(s)</u>	<u>Search Syntax or Instructions</u>	<u>Fields to Search</u>	<u>Specifiers</u>
			"non-hispanic white" OR "Native Americans" OR "Jewish" OR "Native Hawaiians" OR "Pacific Islander" OR "Puerto Ricans" OR "Russian" OR "Latinx" OR "Romanian" OR "Mexican" OR "Chinese" OR "Turkish" OR "Korean" OR "Irish" OR "Kurd" OR "Mongols" OR "Arabs" OR "Uzbek" OR "Indian" OR "British" OR "Palestinian" OR "Kazakhs" OR "Armenian" OR "Albanian" OR "Tibetan" OR Vietnamese" OR "Pakistani" OR "Bangladeshi" OR "Welsh" OR "Scottish").		

APPENDIX E

Search Documentation

<u>Search Date</u>	<u>Full Search ID#</u>	<u>Type of Search</u>	<u>Database or Source</u>	<u>Search Term ID#</u>	<u>Search Syntax or Other Guidelines for the Search</u>	<u>Fields Searched</u>	<u>Search Specifier: Year</u>	<u>Search Specifier: Publication Type</u>	<u>Search Specifier: Age Group</u>	<u># of Records</u>
9/27/2020	001	Electronic Database	MedLine	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("effects")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	34
9/27/2020	002	Electronic Database	PubMed	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("effects")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	36
9/27/2020	003	Electronic Database	PsychARTICLES	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("effects")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	1
9/27/2020	004	Electronic Database	PsychINFO	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("effects")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	10
9/27/2020	005	Electronic Database	SPORTDiscus	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	1

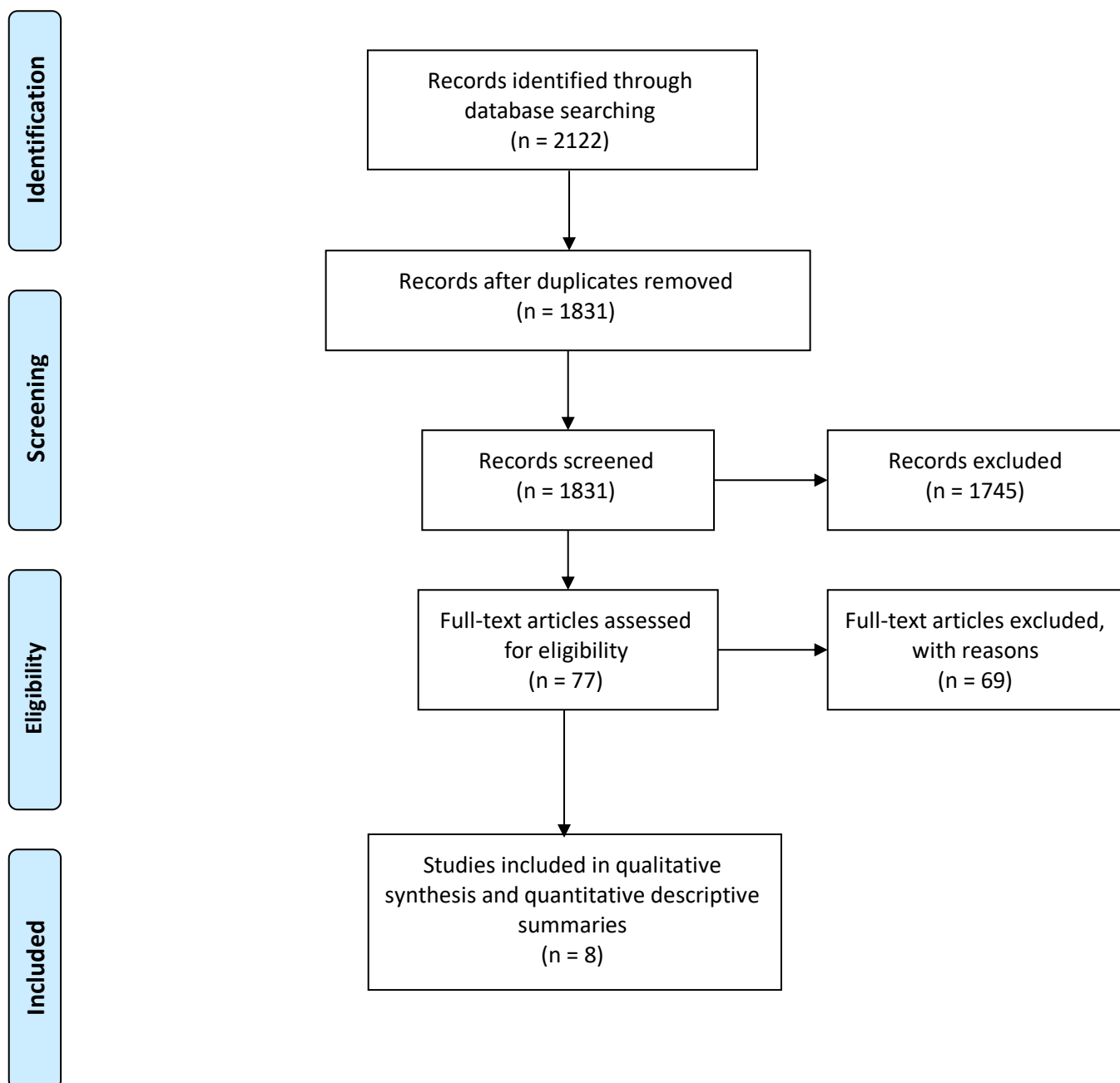
<u>Search Date</u>	<u>Full Search ID#</u>	<u>Type of Search</u>	<u>Database or Source</u>	<u>Search Term ID#</u>	<u>Search Syntax or Other Guidelines for the Search</u>	<u>Fields Searched</u>	<u>Search Specifier: Year</u>	<u>Search Specifier: Publication Type</u>	<u>Search Specifier: Age Group</u>	<u># of Records</u>
					("experiment") AND ("effects")					
9/27/2020	006	Electronic Database	Taylor & Francis Online	1,2,3,4,5,6	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("effects")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	526
9/27/2020	007	Electronic Database	MedLine	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	78
9/27/2020	008	Electronic Database	PubMed	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	82
9/27/2020	009	Electronic Database	PsychARTICLES	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	2
9/27/2020	010	Electronic Database	PsychINFO	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	23



<u>Search Date</u>	<u>Full Search ID#</u>	<u>Type of Search</u>	<u>Database or Source</u>	<u>Search Term ID#</u>	<u>Search Syntax or Other Guidelines for the Search</u>	<u>Fields Searched</u>	<u>Search Specifier: Year</u>	<u>Search Specifier: Publication Type</u>	<u>Search Specifier: Age Group</u>	<u># of Records</u>
					("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")					
9/27/2020	011	Electronic Database	SPORTDiscus	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	3
9/27/2020	012	Electronic Database	Taylor & Francis Online	1,2,3,4,5,7	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("psychotherapy")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	792
9/27/2020	013	Electronic Database	MedLine	1,2,3,4,5,8,9	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("gender") AND ("race")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	9
9/27/2020	014	Electronic Database	PubMed	1,2,3,4,5,8,9	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment")	Title, keywords, abstract	2010 - 2020	Peer-reviewed articles	Adolescence (10- to 19-years-old)	9

<u>Search Date</u>	<u>Full Search ID#</u>	<u>Type of Search</u>	<u>Database or Source</u>	<u>Search Term ID#</u>	<u>Search Syntax or Other Guidelines for the Search</u>	<u>Fields Searched</u>	<u>Search Specifier: Year</u>	<u>Search Specifier: Publication Type</u>	<u>Search Specifier: Age Group</u>	<u># of Records</u>
					AND ("gender") AND ("race")					
9/27/2020	015	Electronic Database	PsychARTICLES	1,2,3,4,5,8,9	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("gender") AND ("race")	Title, keywords, abstract	2010 - 2020	Peer- reviewed articles	Adolescence (10- to 19- years-old)	0
9/27/2020	016	Electronic Database	PsychINFO	1,2,3,4,5,8,9	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("gender") AND ("race")	Title, keywords, abstract	2010 - 2020	Peer- reviewed articles	Adolescence (10- to 19- years-old)	1
9/27/2020	017	Electronic Database	SPORTDiscus	1,2,3,4,5,8,9	("adolescent") AND ("aerobic exercise") AND ("depression") AND ("control group") AND ("experiment") AND ("gender") AND ("race")	Title, keywords, abstract	2010 - 2020	Peer- reviewed articles	Adolescence (10- to 19- years-old)	2

Appendix F  
PRISMA Flow Chart



APPENDIX G

Full Database from Extraction

Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0)  CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5)  CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6)  CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."
Carter, Guo, Turner, Morris, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"No effect on depressive symptoms was found at post-intervention" (i.e., 6 weeks).	"A statistically significant effect on depressive symptoms was found at six-month follow-up in	"Experimental group received "a six week circuit-training consisting of 12 separate session which were run twice weekly"  "The term TAU typically refers to a	33 female, 11 males; assessment of depression outcome measures were not assessed	84 white, 3 other (not stated); assessment of depression outcome measures were not assessed	$d = 0.50$	CDI-2 $\alpha = 0.91$  6 weeks  Intervention -5.21 (-8.29, -2.14)	CDI-2  6 months  Intervention -8.63 (-12.15, -5.12)  TAU	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was

Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
					favour of the intervention"	wide range of standard treatments available to the specific group in question. In this instance, TAU included psychological therapies...no participants reporting exercise as part of their usual treatment."	between genders	between races		TAU -2.64 (-5.92, 0.63)	-3.82 (-7.53, -0.12)	found at six-month follow-up in favour of the intervention."
Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	"Depressive symptoms as measured by the CDRS-R were found...to significantly reduce from pre-to postintervention"	It was only a 6-week study	The authors noted that "As participants were receiving a form of treatment [i.e., psychotherapy] throughout both the baseline and intervention period, these results indicate that the addition of exercise to standard treatments for depression may have contributed to further reduction in depressive symptoms."	7 females, 3 males	Unavailable	$z(N=9) = -2.67, p = .008, r^2 = .40$	CDRS-R $\alpha = .83-.88$ 66.90(11.62) RADS-2 $\alpha = .91-.94$ 86.50(20.87)	CDRS-R 47.00(9.10) RADS-2 66.89(18.25)	A moderate significant reduction in depressive symptoms was found at postintervention

Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0)  CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5)  CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6)  CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."
Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	"Depressive symptoms as measured by the CDRS-R were found...to significantly reduce from pre-to postintervention"	It was only a 6-week study	The authors noted that "As participants were receiving a form of treatment [i.e., psychotherapy] throughout both the baseline and intervention period, these results indicate that the addition of exercise to standard	7 females, 3 males	Unavailable	$z (N = 9) = -2.67, p = .008, r^2 = .40$	CDRS-R $\alpha = .83-.88$ 66.90(11.62)  RADS-2 $\alpha = .91-.94$ 86.50(20.87)	CDRS-R 47.00(9.10)  RADS-2 66.89(18.25)	A moderate significant reduction in depressive symptoms was found at postintervention



Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
						treatments for depression may have contributed to further reduction in depressive symptoms."						
Carter, Guo, Turner, Morres, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"No effect on depressive symptoms was found at post-intervention" (i.e., 6 weeks).	"A statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention"	"Experimental group received "a six week circuit-training consisting of 12 separate session which were run twice weekly"  "The term TAU typically refers to a wide range of standard treatments available to the specific group in question. In this instance, TAU included psychological therapies...no participants reporting exercise as part of their usual treatment."  "No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."	33 female, 11 males; assessment of depression outcome measures were not assessed between genders	84 white, 3 other (not stated); assessment of depression outcome measures were not assessed between races	$d = 0.50$	CDI-2 $\alpha = 0.91$ 6 weeks Intervention -5.21 (-8.29, -2.14) TAU -2.64 (-5.92, 0.63)	CDI-2 6 months Intervention -8.63 (-12.15, -5.12) TAU -3.82 (-7.53, -0.12)	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."

Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
Fidelix, Lofrano-Prado, Fortes, Hill, Caldwell, Botero, and Prado	2019	Quantitative, RCT	13-18	None (only assessed at baseline and 24 weeks)	Beck Depression Inventory scores decreased significantly in both groups ( $P \leq .01$ ) with higher ES observed for HIG ( $d = 1.16$ ; ES: large) compared with LIG ( $d = 0.45$ ; ES: small).	24 weeks of supervised aerobic training on treadmills. Those in the [high intensity group] HIG exercised at an intensity corresponding to individual ventilatory threshold 1 (VT1), whereas those in the [low intensity group] LIG exercised at a speed 20% below the VT1."	N/A	N/A	"the effect size (ES) for each intervention was calculated as proposed by Cohen (d)."	BDI $\alpha = .89$ HIG 19.86(7.75) LIG 18.86(8.44)	BDI HIG 12.29(5.69) LIG 14.85(10.14)	The results from the present study demonstrate that supervised exercise in a multi-dimensional intervention has positive effects on symptoms of depression.

Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Outcome Variable Assessed: treatment modality	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
						combat...depression were discussed with the adolescents."						
Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment"	"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."  "For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."  "Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$  CDRS $\alpha = .83-.88$  K-SADS-P $\alpha = 0.94$  CBT 25.0(12.0)  CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5)  CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6)  CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."

## APPENDIX H

### Data Extraction and Collection Forms

<b>Document ID#</b>

<b>Authors and Year</b> ( <i>last names of authors and year of publication, e.g., Johnson, Jones, and Jackson 2011</i> )

<b>Full Document Title</b>

<b>Research Variables</b>

### 1. General Information

1. <b>Date form completed</b> ( <i>dd/mm/yyyy</i> )	
2. <b>Initials/ID of person extracting data</b>	
3. <b>Source/Publication Type</b> ( <i>journal, book, conference, report, dissertation, abstract, etc.</i> )	
4. <b>Source Name</b> ( <i>Title of Journal, Book, Organization, etc.</i> )	
5. <b>Publication Status</b> ( <i>Published, Unpublished</i> )	
6. <b>Document Language</b>	

### 2. Design Characteristics and Methodological Features

	<b>Descriptions as stated in report/paper</b>	<b>Location in text</b> ( <i>pg &amp; ¶/fig/table</i> )
7. <b>Aim of study</b>		
8. <b>General Method</b> (Quant, Qual, Mixed)		
9. <b>Design or Specific Research Approach</b>		
10. <b>Intervention Characteristics:</b> <b>Treatment Type</b> (in lieu of psychotherapy or adjunct to psychotherapy)		

	Descriptions as stated in report/paper	Location in text (pg & ¶/fig/table)
11. Treatment Measurement (e.g., BDI-II)		

### 3. Assessment of Research Variables

RESEARCH VARIABLES	How Assessed ( <i>Measure, Observation, Interview Question, Archival, etc.</i> )	Reliability/Validity/Utility	Location in text (pg & ¶/fig/table)
12. Variable 1: short-term effects of aerobic exercise			
13. Variable 2: long-term effects of aerobic exercise			
14. Variable 3: aerobic exercise in lieu of psychotherapy			
15. Variable 4: aerobic exercise as an adjunct to psychotherapy			
16. Variable 5: effects of aerobic exercise in gender			
17. Variable 6: effects of aerobic exercise in race			

### 4. Study Participant Characteristics and Recruitment

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
18. Population of Interest		
19. Recruitment Methods		
20. Sample Size		
21. Age		
22. Gender		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
23. Race/Ethnicity		

### 5. Setting Characteristics

	Descriptions as stated in report/paper	Location in text (pg & ¶/fig/table)
24. Study Location		
25. Data Collection Setting(s)		

### 6. Analyses Conducted

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
26. Descriptive Statistics used		
27. Inferential Statistics used		
28. Qualitative Analyses conducted		
29. Outcome findings		

### 7. Results

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
30. Key Result #1: What are the short-term effects of exercise on depression?		
31. Key Result #2: What are the long-term effects of exercise on depression?		
32. Key Result #3: Did exercise in lieu of psychotherapy or exercise as an adjunct to psychotherapy have better outcomes for depressive symptoms?		
33. Key Result #4: Did the results vary by gender?		

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
34. Key Result #5: Did the results vary by race?		
35. Notes:		

### 8. Conclusions and Follow-up

	Description as stated in report/paper	Location in text (pg & ¶/fig/table)
36. Key conclusions of study authors		
37. Study Author's Recommendations for Future Research		
38. Does the study directly address your review question? <i>(any issues of partial or indirect applicability)</i>		
39. Your Take-Aways: General		
40. Your Take-Aways: Implications for Practice		
41. Salient Study Limitations (to inform Quality Appraisal)		
42. References to other relevant studies		
43. Other publications from this dataset		
44. Further study information needed? <i>(from whom, what and when, contact info)</i>		
45. Correspondence received <i>(from whom, what and when)</i>		



APPENDIX I

Quality Appraisal Forms

**Author(s) and Year:**  
**Study ID#**

**1. Methodology:** Quantitative                      Qualitative                      Mixed Methods

**2. Specific Design/Inquiry Approach:**

RATING SCALE:    Strong=3            Good/Adequate=2            Weak=1            Missing=0            N/A

**3. Strength of Literature Foundation and Rationale for Study:** \_\_\_\_\_

(Current and relevant references, background literature sufficiently comprehensive, Rationale for study clearly stated, etc.)

**4. Clarity and specificity of Research Aims/Objectives/Questions:** \_\_\_\_\_

**5. Quality of research design or methodological approach:** \_\_\_\_\_

(Clear description of design and methodological approach)

**6. Sample Selection and Characteristics:** \_\_\_\_\_

(Detailed description of sample characteristics)

**7. Measures/Data Collection Tools:** \_\_\_\_\_

(Rationale for selection, appropriateness for assessing variables)

**8. Data Collection:** \_\_\_\_\_

(POSSIBLE CONSIDERATIONS: data collection procedures clearly described, intervention strategies and implementation described in detail, quality of data collected, attrition, etc.)

**9. Analysis of Data:** \_\_\_\_\_

(Results presented clearly and comprehensively)

**10. Discussion of Study Limitations:** \_\_\_\_\_

(Identifies and discusses limitations in the context of design/strategy utilized)

**11. Consideration of culture and diversity:** \_\_\_\_\_

(Attention to diversity within sample, includes culturally appropriate methods and tools, avoids biased language, uses appropriate terminology, etc.)

**12. OVERALL RATING:**

EXEMPLARY  
(all "3"s)

STRONG  
(mostly "3"s)

GOOD/ADEQUATE  
(mostly "2"s)

WEAK  
(mostly "1"s)

## APPENDIX J

Screening and Selection: Short- and Long-term Effects of Aerobic Exercise

AUTHOR(S)	YEAR	ABBREVIATED TITLE	DATABASES/SOURCES	TITLE AND/OR KEYWORD SCREEN: Decision Date	ABSTRACT SCREEN: Decision Date	FULL-TEXT SCREEN?	INCL (P): Age	INCL (P): Diagnosis	INCL (I): Psychotherapy	INCL (C): Comparison Conditions	INCL (O): Outcome Measure	INCL(S): Study Design	EXCL (P): Dual Diagnosis	EXCL (P): Combination Studies	EXCL (P): Anaerobic or Strength	EXCL (P): Qualitative	EXCL (P): Follow-ups >53 weeks	EXCL (P): Systematic Reviews	REVIEWER DECISION - DATE	FINAL DECISION	DECISION NOTES

APPENDIX K

Evidence Table for Effects and Aerobic Exercise

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Effect Size	Pre-test	Post-test	Results/Main Findings
1	Carter, Guo, Turner, Morres, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"No effect on depressive symptoms was found at post-intervention" (i.e., 6 weeks).	"A statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention"	$d = 0.50$	CDI-2 6 weeks -5.21 (-8.29, -2.14)	CDI-2 6 months -8.63 (-12.15, -5.12)	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."
2	Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	Unknown, authors only stated that "findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week	"findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week	$d = 0.57$	CBT-HL 17.1 (2.0)	CBT-HL change through end of follow-up -11.6(2.3)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: short-term effects of exercise	Outcome Variable Assessed: long-term effects of exercise	Effect Size	Pre-test	Post-test	Results/Main Findings
					follow-up assessment"	follow-up assessment"				
3	Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	"Depressive symptoms as measured by the CDRS-R were found...to significantly reduce from pre- to postintervention"	N/A, it was only a 6-week study	$z (N = 9) = -2.67, p = .008, r^2 = .40$	CDRS-R 66.90(11.62) RADS-2 86.50(20.87)	CDRS-R 47.00(9.10) RADS-2 66.89(18.25)	A moderate significant reduction in depressive symptoms was found at postintervention

APPENDIX L

Screening and Selection: Psychotherapy and Aerobic Exercise



AUTHOR(S)	YEAR	ABBREVIATED TITLE	DATABASES/SOURCES	TITLE AND/OR KEYWORD SCREEN: Decision Date	ABSTRACT SCREEN: Decision Date	FULL-TEXT SCREEN?	INCL (P): Age	INCL (P): Diagnosis	INCL (I): Psychotherapy	INCL (C): Comparison Conditions	INCL (O): Outcome Measure	INCL (S): Study Design	EXCL (P): Dual Diagnosis	EXCL (P): Combination Studies	EXCL (P): Anaerobic or Strength	EXCL (P): Qualitative	EXCL (P): Follow-ups >53 weeks	EXCL (P): Systematic Reviews	REVIEWER DECISION - DATE	FINAL DECISION	DECISION NOTES

## APPENDIX M

## Evidence Table for Psychotherapy and Aerobic Exercise Results

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: exercise model	Effect Size	Pre-test	Post-test	Results/Main Findings
4	Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	<p>"Adolescents randomized to both treatment conditions received an individual CBT protocol for adolescent depression."</p> <p>"For adolescents assigned to CBT-HL, the core modules for depression (described earlier) were enhanced to include attention to diet and physical activity...Weekly 60-min group aerobic exercise sessions were required and facilitated by a physical therapist."</p> <p>"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."</p>	$d = 0.57$	<p>BDI-II, CDRS, K-SADS-P</p> <p>24 weeks CBT 6.9(7.5)</p> <p>BDI-II, CDRS, K-SADS-P</p> <p>CBT 25.0(12.0)</p> <p>CBT-HL 22.0(11.0)</p>	<p>BDI-II, CDRS, K-SADS-P</p> <p>9.0(10.9)</p> <p>48 weeks CBT 6.0(5.6)</p> <p>CBT-HL 10.3(14.4)</p>	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."
5	Radovic, Melvin, and Gordon	2017	Mixed methods, Within-subjects design	12-18	The authors noted that "The 4-week exercise intervention [was at a] moderate intensity for a minimum frequency of three times a week for 30 min...over the 4-week	$z (N = 9) = -2.67, p = .008, r^2 = .40$	<p>CDRS-R 66.90(11.62)</p> <p>RADS-2 86.50(20.87)</p>	<p>CDRS-R 47.00(9.10)</p> <p>RADS-2 66.89(18.25)</p>	A moderate significant reduction in depressive symptoms was found at postintervention

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: exercise model	Effect Size	Pre-test	Post-test	Results/Main Findings
					period."  As participants were receiving a form of treatment [i.e., psychotherapy] throughout both the baseline and intervention period, these results indicate that the addition of exercise to standard treatments for depression may have contributed to further reduction in depressive symptoms."				
6	Carter, Guo, Turner, Morres, Khalil, Brighton, Armstrong, and Callaghan	2015	Quantitative, RCT	14-17	"Experimental group received "a six week circuit-training consisting of 12 separate session which were run twice weekly"  "The term TAU typically refers to a wide range of standard treatments available to the specific group in question. In this instance, TAU included psychological therapies...no participants reporting exercise as part of their	$d = 0.50$	CDI-2 6 weeks Intervention -5.21 (-8.29, -2.14) TAU -2.64 (-5.92, 0.63)	CDI-2 6 months Intervention -8.63 (-12.15, -5.12) TAU -3.82 (-7.53, -0.12)	"No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: exercise model	Effect Size	Pre-test	Post-test	Results/Main Findings
					usual treatment."  "No effect on depressive symptoms was found at post-intervention, however a statistically significant effect on depressive symptoms was found at six-month follow-up in favour of the intervention."				
7	Fidelix, Lofrano-Prado, Fortes, Hill, Caldwell, Botero, and Prado	2019	Quantitative, RCT	13-18	24 weeks of  "Adolescents underwent 3 sessions per week of supervised aerobic training on treadmills. Those in the [high intensity group] HIG exercised at an intensity corresponding to individual ventilatory threshold 1 (VT1), whereas those in the [low intensity group] LIG exercised at a speed 20% below the VT1."  "Psychological counseling was conducted for 1 hour each week in small groups (~9 adolescents/group,	"the effect size (ES) for each intervention was calculated as proposed by Cohen (d)."	BDI  HIG 19.86(7.75)  LIG 18.86(8.44)	BDI  HIG 12.29(5.69)  LIG 14.85(10.14)	The results from the present study demonstrate that supervised exercise in a multi-dimensional intervention has positive effects on symptoms of depression.

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: exercise model	Effect Size	Pre-test	Post-test	Results/Main Findings
					mixed in terms of HIG or LIG) by a clinical psychologist. In addition, targeting psychological motivation for compliance, session themes related to body image, eating disorders (symptoms and consequences), the relationship between food and feelings, family and social problems, strategies to enhance mood and combat...depression were discussed with the adolescents."				

APPENDIX N

Screening and Selection: Race/Ethnicity and Gender and Aerobic Exercise

AUTHOR(s)	YEAR	ABBREVIATED TITLE	DATABASES/SOURCES	TITLE AND/OR KEYWORD SCREEN: Decision Date	ABSTRACT SCREEN: Decision Date	FULL-TEXT SCREEN?	INCL (P): Age	INCL (P): Diagnosis	INCL (I): Psychotherapy	INCL (C): Comparison Conditions	INCL (O): Outcome Measure	INCL(S): Study Design	EXCL (P): Dual Diagnosis	EXCL (P): Combination Studies	EXCL (P): Anaerobic or Strength	EXCL (P): Qualitative	EXCL (P): Follow-ups >53 weeks	EXCL (P): Systematic Reviews	REVIEWER DECISION - DATE	FINAL DECISION	DECISION NOTES



APPENDIX O

Evidence Table for Gender, Race, and Aerobic Exercise Results

ID#	Author(s)	Year	Research Methodology and Design	Sample Characteristics (age)	Outcome Variable Assessed: genders of sample	Outcome Variable Assessed: races of sample	Effect Size	Pre-test	Post-test	Results/Main Findings
8	Jelalian, Jandasek, Wolff, Seaboyer, Jones, and Spirito	2019	Quantitative, RCT	12-18	73% female, 27% male; assessment of depression outcome measures were not assessed between genders	61% white, 36% Latino, 1% other; assessment of depression outcome measures were not assessed between races	$d = 0.57$	BDI-II $\alpha = .92-.95$ CDRS $\alpha = .83-.88$ K-SADS-P $\alpha = 0.94$ CBT 25.0(12.0) CBT-HL 22.0(11.0)	BDI-II, CDRS, K-SADS-P  24 weeks CBT 6.9(7.5)  CBT-HL 9.0(10.9)  48 weeks CBT 6.0(5.6)  CBT-HL 10.3(14.4)	"Findings indicate that CBT-HL and CBT conditions both resulted in a clinically significant reduction in depressed mood by the 48-week follow-up assessment."

APPENDIX P

IRB Approval

# PEPPERDINE UNIVERSITY

## Graduate & Professional Schools Institutional Review Board

July 31, 2020

**Protocol #: 73120**

**Project Title:** The Impact of Exercise on Adolescents with Depression: A Systematic Review of the Literature.

Dear Matthew:

Thank you for submitting a "GPS IRB Non-Human Subjects Notification Form" for *The Impact of Exercise on Adolescents with Depression: A Systematic Review of the Literature* project to Pepperdine University's Institutional Review Board (IRB) for review. The IRB has reviewed your submitted form and all ancillary materials. Upon review, the IRB has determined that the above titled project meets the requirements for *non-human subject research* under the federal regulations 45 CFR 46.101 that govern the protection of human subjects.

Your research must be conducted according to the form that was submitted to the IRB. If changes to the approved project occur, you will be required to submit *either* a new "GPS IRB Non-Human Subjects Notification Form" or an IRB application via the eProtocol system (<http://irb.pepperdine.edu>) to the Institutional Review Board.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the IRB and documenting the adverse event can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* at <https://community.pepperdine.edu/irb/policies/>.

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval.

On behalf of the IRB, we wish you success in this scholarly pursuit.

Sincerely,

Institutional Review Board (IRB)  
Pepperdine University

cc: Mrs. Katy Carr, Assistant Provost for Research  
Dr. Judy Ho, Graduate School of Education and Psychology IRB Chair

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