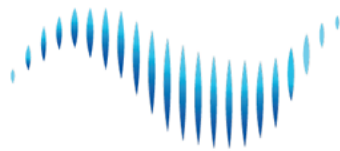


# MOVE YOUR MENTAL HEALTH™

A REVIEW OF THE SCIENTIFIC  
EVIDENCE ON THE ROLE  
OF EXERCISE AND PHYSICAL  
ACTIVITY ON MENTAL HEALTH



JOHN W. BRICK  
MENTAL HEALTH FOUNDATION

MAY 2021

## About Us

The John W. Brick Mental Health Foundation is changing the way the world treats mental health. Our purpose is integrating salutogenic approaches – such as exercise, nutrition, and mind-body practices – for treating mental illness and promoting mental wellness. We 1) fund and promote evidence-based research on how exercise, nutrition, and mind-body practices benefit mental health resilience, 2) support programs and initiatives that integrate evidence-based holistic approaches into the mental health care delivery system, and 3) serve as a collaborative hub for an array of partners to advance a roadmap for an integrated approach to mental health care.

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This report can be downloaded or printed at

[www.johnwbrickfoundation.org/moveyourmentalhealthreport](http://www.johnwbrickfoundation.org/moveyourmentalhealthreport)

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# MOVE YOUR MENTAL HEALTH EXECUTIVE SUMMARY

**M**ental Illness is prevalent in the United States and globally, with 26% of adults in the US experiencing mental illness at any given year ([Johns Hopkins Medicine, 2021](#)). Depression is one of the leading causes of disability worldwide. Suicide rates are up 35% since 1999, and someone in the world takes their own life every 40 seconds. During COVID-19, these numbers have drastically increased. By any measure, mental illness is an epidemic in the United States and around the world, and our attempts to treat it are only partially successful.

There is an urgent need to 1) discover more effective interventions and identify better means of prevention to ease the suffering, societal cost, and loss of life associated with mental illness, and 2) identify better and complementary means of prevention and treatment.

Physical health is clearly intertwined with mental health in a bidirectional fashion. Scientific evidence shows that changes in thinking patterns and behaviors affect neurological, endocrine, and immune systems. Conversely, disruption in these biological systems negatively impacts mental health. In addition to medication, holistic approaches such as exercise and physical activity, nutrition, and mind-body practices such as yoga can improve mental health. However, these approaches are rarely included in prevention and treatment of mental illness, and mental health care providers are not well trained in their evidence-based or clinical utility.

In particular, an important point of intervention at the nexus of physical health and mental health is reducing sedentary behavior and increasing physical activity. This can be challenging, since the same symptoms that exercise and physical activity can help to improve, such as depression, anxiety, lethargy, and impairments in functioning, serve as barriers to increasing exercise and physical activity. Having said that, multiple clinical trials indicate that introducing exercise and physical activity in early intervention and treatment for mental health conditions is feasible and effective, particularly in the form of supervised group activities or when paired with personal training.

Research overwhelmingly supports a beneficial role of exercise and increased physical activity for addressing mental health issues, particularly depression and anxiety, for which a combination of cardiovascular and aerobic exercise and strength training at moderate to high intensity several times per week appears to be supported by the evidence. Exercise appears to improve mental health through social and self-efficacy pathways, as well as biological pathways – such as increasing brain neurotransmitters and improving hormone function involved in mental health.

More research is needed on what type, duration, and intensity of exercise are ideal for specific symptom configurations and populations, and for more serious mental illnesses such as schizophrenia and bipolar disorder. Innovation is required in customization of exercise and physical activity protocols for specific populations and disorders, and overcoming barriers to implementation. Effectiveness studies in real-world settings are necessary to determine large-scale feasibility and effects beyond controlled research settings. Promising trends deserve further investigation such as exergaming, positive stress activities such as exercise or breathing combined with heat or cold exposure, and affect-based exercise prescriptions which take participant enjoyment into account in addition to exercise outcomes. And studies investigating longer intervention periods are needed to assess stable symptom reduction.

### What is the Move Your Mental Health™ Report?

The Move Your Mental Health Report is an overview of scientific evidence published over the last 30 years on the link between exercise and mental health. The report is the outcome of a scoping review of over 1000 scientific studies to date on how exercise and physical activity is related to mental health.

A scoping review casts a wide net to determine the number of studies available on a specific topic, provide an overview of the topic, summarize themes across articles, and identify gaps in research. A search was conducted to attempt to locate every article published on any form of exercise, physical activity, or type of movement in relation to any mental health outcome between January 1, 1990 and November 15, 2020.

We identified 1444 articles including qualitative and correlational studies, systematic reviews and meta-analyses, case studies and theoretical papers, and clinical trials. These have been categorized by type of exercise, type of mental health condition or outcome, numbers and types of studies in each category, and whether results were statistically significant or not. The exercise categories reflect the types of exercise reported on in the literature, and those where a specific type of exercise or movement was not specified placed into the category of “general physical activity.”



**“Physical health is clearly intertwined with mental health. Moving our bodies regularly is one of the key elements in the ecosystem of factors that keep us mentally and emotionally balanced.”**



## What is the Purpose of the Report?

The scientific literature on exercise, physical activity and mental health outcomes is broad and substantial in volume, making it difficult to navigate. The purpose of this project has been to:

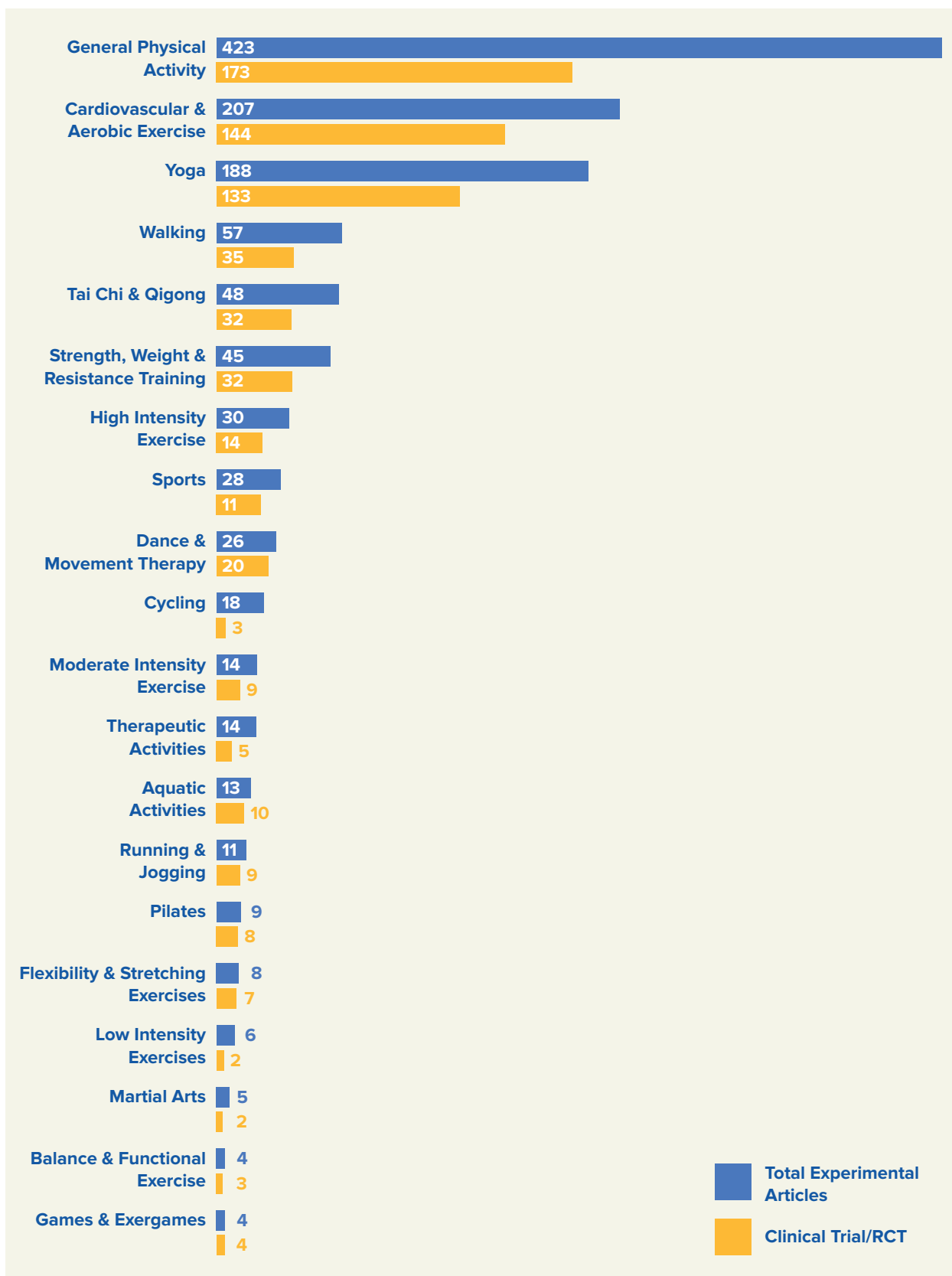
- 1) identify as many published and peer-reviewed scientific articles on the topic as possible;
- 2) provide an overview of and access to articles in each category of exercise stratified by type of exercise and mental health outcome,
- 3) summarize the proportion of articles reporting significant results (positive or not) in each category,
- 4) describe trends across the results of each category and in the overall literature, and
- 5) provide accompanying online data visualization that allows viewers to quickly grasp and explore the existing data in their categories of interest.

This report is a resource for all stakeholders – mental health professionals, fitness and wellness professionals, educators, clinic directors, policy makers, patients, and families – to assess the evidence for various forms of exercise and physical activity for mental health. Our intention is that the report helps readers identify activities and interventions that hold promise for their situation or setting, and learn what factors can support integration of evidence-based activities into treatment, early intervention and prevention efforts. We also highlight which types of physical activity hold the most promise for which mental health outcomes, and which do not appear to be helpful. Finally, this report is a preliminary step in identifying gaps in evidence, limitations of current research, and the most promising research directions for future funding decisions by the JWB Foundation, our partners and other funding agencies.

## How Many Studies Support the Role of Exercise in Mental Health?

When we look at all studies identified in this project, they overwhelmingly report positive relationships between exercise/physical activity and mental health outcomes. Out of a total of 1158 number of experimental studies included in this review, 1029 or 89% of them reported significant positive relationships between physical activity and mental health outcomes. Types of physical activity with the greatest number of positive studies were general physical activity (a term referring to the amount of daily or weekly physical activity people engage in, irrespective of type) with 370 studies showing significant and positive results, cardiovascular and aerobic activity with 189 positive studies, and yoga with 165 positive studies.

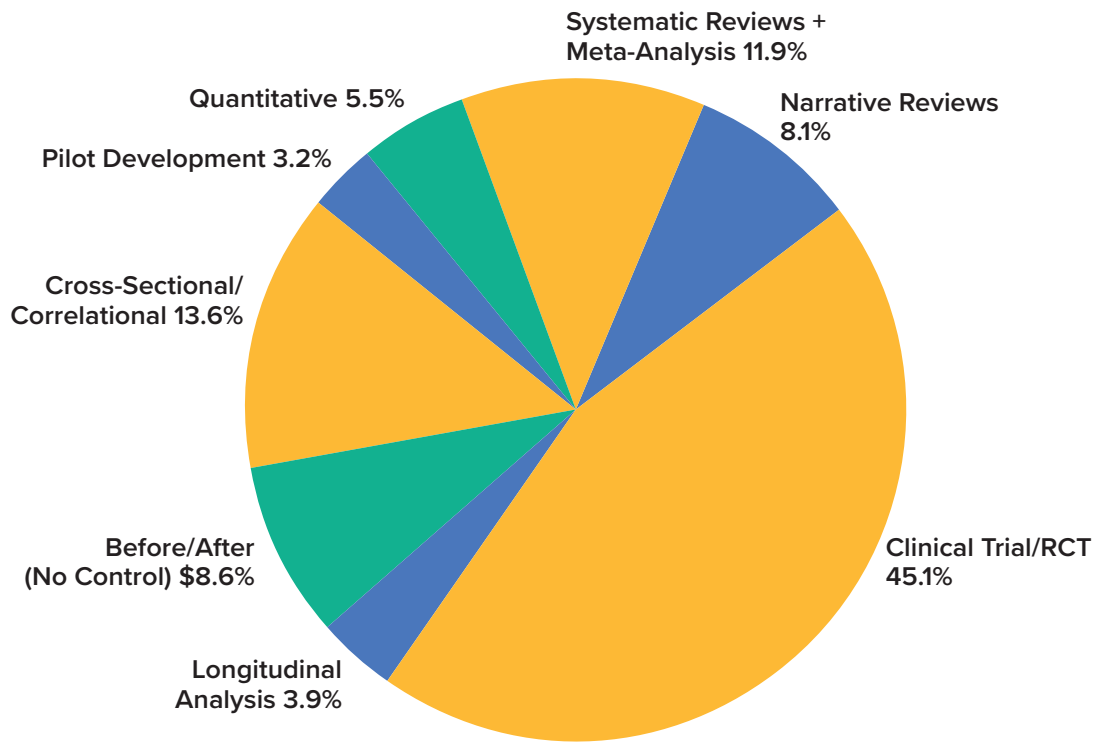
When examining only randomized controlled trials (RCTs) (in other words, studies that assigned people randomly to groups that exercised vs. groups that did not), the vast majority report positive effects of exercise/physical activity on mental health outcomes. Fifty-six percent of the studies we reviewed were randomized trials (see Figure 1). Out of a total of 656 number of randomized trials included in this review, 574 or 87% of them reported significant positive relationships between physical activity and mental health.



**Figure 1:** Number of Research and Randomized Controlled Trial (RCT-Only) Articles Categorized by Exercise Type

## What Types of Studies Were Reviewed?

While Randomized Clinical Trials are the gold standard for determining effectiveness of exercise and physical activity on mental health outcomes, other types of studies also provide useful information. Figure 2 displays the types and breakdown of studies, systematic reviews, narrative reviews, and meta-analyses we reviewed to create this report.



**Figure 2:** Types of Studies Reviewed for this Report

## What are the Key Conclusions?

### Do Exercise and Physical Activity Benefit Mental Health?

- Existing scientific research overwhelmingly indicates that exercise and physical activity benefit mental health.
- 89% of all published peer-reviewed research between 1990 and 2020 found a positive, statistically significant relationship between exercise/physical activity and mental health.
- In general, the optimal type, intensity, and duration of exercise remain unclear, although several conclusions about specific types of exercise can be made, detailed below.

### How Much Exercise and How Often?

- Overall, three to five 30-45-minute moderate to vigorous exercise sessions per week appear to deliver optimal mental health benefits (Chekroud et al., 2018).
- High-frequency exercise (3-5 times per week) is better for reducing depressive symptoms than low-frequency exercise (1 time per week) (Womack and Safranek, 2010).
- More exercise is not always better. There appears to be a U-shaped curve, in which people who engage in moderate to vigorous exercise 3-5 times per week show better mental health than those who exercise under three or over five times per week. Some high-intensity exercise can increase anxiety immediately post-exercise.

### What Type of Exercise?

- High-intensity exercise regimens are generally more effective than low-intensity regimens (Aylett et al., 2018).
- Combining or alternating strength/resistance training with cardiovascular/aerobic exercise shows stronger benefits on mental health outcomes than either one alone.
- Mindfulness-based activities like yoga and tai chi, though they can be lower intensity forms of movement, deliver more mental health benefits than walking.
- Team sports, cycling, and aerobic or gym exercise are the top three forms of exercise associated with over 20% fewer “poor mental health” days per month (Chekroud et al., 2018).

### What Mental Health Outcomes are Most Impacted by Exercise?

- Exercise is strongly associated with general mental and emotional well-being including reduced stress, and improved mood and quality of life.
- Evidence strongly supports cardiovascular/aerobic exercise for reducing depression, showing medium to large effect sizes.
- Evidence shows moderate but reliable effect sizes for cardiovascular/aerobic exercise reducing symptoms in people with anxiety disorders.
- Yoga and other mindful exercises such as Tai Chi and Qigong show strong evidence for reducing symptoms of anxiety and depression.
- In severe mental illness (SMI) such as schizophrenia, exercise appears to benefit physical health and “negative” psychological symptoms such as emotional numbing and being withdrawn, more than “positive” symptoms such as hallucinations and delusions.

## What Recommendations Can Be Made?

### Clinical Recommendations

- **Depression.** People meeting criteria for depressive disorders should be prescribed 30-45 minutes of moderate to vigorous exercise 3-5 times per week, ideally beginning with structured group supervised exercise, or individual coaching by a physical therapist or fitness professional.
- **Anxiety:** Evidence supports prescribing yoga, qi gong, or mind-body movement for people experiencing symptoms of anxiety. Cardiovascular/aerobic and strength/resistance training should be encouraged and monitored for effectiveness.
- **Clinical Delivery:** Recommendations for exercise, physical activity, or movement for people experiencing mental illness symptoms should be accompanied by evidence-based support for behavior change, such as:
  - motivational interviewing
  - structured group and peer support
  - initial supervision individually or in groups
  - gradually increasing exercise duration and intensity
  - online and app-based programs
  - behavior change coaching
- **Customization:** Adaptations of exercise interventions to be relevant to patient enjoyment, cultural and regional diversity should be explored. Without this, difficulty adhering to recommendations may backfire, increasing depression or anxiety.

Overall, based on the numerous meta-analyses and controlled trials reviewed for this report, we conclude that exercise and movement can now be considered mainstream elements of mental health care, particularly anxiety and depression, as opposed to optional complementary or alternative modalities.

### Research Recommendations

- **Optimal Dose:** Future research should investigate variations in frequency, intensity, type, and time (F.I.T.T.) or “dose” of exercise on mental health outcomes, and begin to converge on data-driven and consensus-based standards.
- **Translational Research:** For exercise types and mental health outcomes showing robust effects, pragmatic trials allowing scalable replication and implementation in routine practice are needed.
- **Mechanisms:** Identification of psychological mediators and biomarkers responsible for antidepressant/anxiety responses to exercise should be prioritized.
- **Serious Mental Illness:** More research should focus on innovating types of exercise/physical activity that are feasible with people with serious mental illness, and investigate effects.
- **Treatment Matching:** A one-size fits all approach is unlikely to be successful. Future studies should focus on identifying subgroups based on symptoms and biopsychosocial characteristics to examine differential responses to exercise interventions ([Schuch et al., 2017](#))

## What is Trending in Exercise and Mental Health?

### What is the future of exercise? Among the trends discussed in this report:

- Stress-reduction is a universal goal in well-being research, but studies indicate that positive stress such as intense breathing and exposure to heat or cold may have mental health benefits.
- Exergaming, or gamification of exercise using video games and virtual/augmented reality are proliferating and becoming immensely popular. These exergames are engineered to be emotionally, socially, and biochemically rewarding and may be powerful for reinforcing new behaviors.
- Community-based exercise interventions, such as the “walking school bus” in which families walk kids to school together, hold promise for incorporating social and peer support, intergenerational wellness, and customizing exercise to be culturally-aligned.
- Green exercise including physical activity or exercise that takes place outside may add value, benefiting mental health more than exercise alone.

### Take Home Messages

- Exercise should be integrated into the treatment of people with depressive symptoms or major depression;
- Exercise (along with mindful movement such as yoga, Tai Chi or Qigong) should be strongly considered for integration into treatment of symptoms of anxiety;
- The evidence is not strong enough in either direction to exclude the possibility exercise may be beneficial for these more serious forms of mental illness, or to recommend it strongly;
- Exercise and physical activity may play a protective role – reducing risk for mental illness – as well as helping to sustain mental wellness over time.

## Explore the Data

### To get a sense of the scientific literature on this topic, these articles will get you started:

- Association between physical exercise and mental health in 1.2 million individuals in the USA between 2011 and 2015: a cross-sectional study ([Chekroud et al., 2018](#))
- Physical Exercise in Major Depression: Reducing the Mortality Gap While Improving Clinical Outcomes ([Murri et al., 2019](#))
- Does Exercise Alleviate Symptoms of Depression ([Womak & Safranek, 2010](#))
- Effects of exercise and physical activity on anxiety ([Anderson & Shivakumar, 2013](#))

### To learn more about the international landscape of mental wellness, we recommend:

- Mental Wellness: Pathways, Evidence and Horizons ([Mental Wellness Institute, 2018](#))





## INTRODUCTION

# MENTAL ILLNESS IS EPIDEMIC

**E**ighteen percent of adults in the United States are living with a mental illness at any given time ([Mental Health America](#)). Two hundred and sixty-four million people around the globe suffer from depression, and it is one of the leading causes of disability worldwide ([World Health Organization, 2020](#)).

Mental illness increases mortality. A meta-analysis ([Walker et al., 2015](#)) showed that across 24 studies, a median of 10 years of life was lost among those with mental illnesses (half the studies estimated above 10 and half below), and that 14.3% of deaths worldwide, or approximately 8 million deaths each year, were attributable to mental disorders. This makes mental disorders rank among the most substantial causes of death worldwide. Suicide is the second leading cause of death in people ages 10 – 34 years old, and rates are up 35% since the year 1999 ([Galvin, 2020](#)). On average, someone in the world dies from suicide every 40 seconds ([World Health Organization](#)).

During COVID-19, rates of subclinical mental distress (symptoms that do not reach the threshold of a psychiatric disorder), and diagnosed mental illness increased substantially. In a Kaiser Family Foundation Tracking Poll conducted in mid-July 2020, 53% of adults in the United States reported that their mental health had been negatively impacted due to worry and stress over the coronavirus, significantly higher than the 32% reported in March. Many adults also reported specific negative impacts on their mental health and wellbeing, such as difficulty sleeping (36%) or eating (32%), increases in alcohol consumption or substance use (12%), and worsening chronic conditions (12%), due to worry and stress over the coronavirus. A CDC poll in June 2020 showed that nearly 11% of respondents said they had seriously considered suicide in the preceding 30 days, more than twice the rate reported in a 2018 survey ([Substance Abuse and Mental Health Services Administration, 2018](#)).

By any measure, mental illness is an epidemic in the United States and around the world, and our attempts to treat it are only partially successful. There is an urgent need to discover more effective interventions and to identify better means of prevention to ease the suffering, societal cost, and loss of life associated with mental illness, and to identify better and complementary means of prevention and treatment. Aside from clinically diagnosable mental illness, general psychological well-being is important for individual and collective flourishing. Well-being includes not only the absence of disease but also a sense of opportunity, happiness, and lack of stress – promoting resilience, buffering the negative impact of stressful events, and improving health throughout the life course ([Arora et al., 2016](#)). Learning more about how we can bolster psychological well-being in individuals and communities has far-reaching implications.

## **Mental Health is Related to Physical Health**

The ancient Greeks believed that mental and physical health were interrelated. From the fourth century BC, founders of the field of medicine including Galen and Hippocrates and the healing temple the Asclepieion of Kos included physical exercise, massage and walks in treatment of psychiatric problems, believing that they fostered inner peace and well-being of the soul ([Kleisiaris et al., 2014](#)). A quote attributed to Gautama Buddha (500 B.C.) is “To keep the body in good health is a duty... otherwise we shall not be able to keep our mind strong and clear.” In many cultures, healing traditions (such as Traditional Chinese Medicine and Ayurveda), mental and physical health were not viewed separately, and remain integrated in traditional practice today.

As the practice of Western medicine evolved over time, a duality between mind and body became the norm. In the 17th century, French Philosopher Rene Decartes described the mind and consciousness as being separate from the body and the physical world, allowing science the freedom to investigate the physical body, and break free from religious and superstitious ideas. This distinction advanced medicine tremendously, but placed matters of the mind and spirit firmly in the realm of religion, philosophy, and later, psychiatry and psychology. To this day, physical care is delivered separately from psychological/psychiatric care, with different schools of thought, infrequent crossover between mental health care and primary care treatment plans, and differences in access and insurance coverage.

However, we are now regaining an understanding that physical health is clearly intertwined with mental health. An exponentially increasing body of science is reconceptualizing how we think about mental illness: psychological ailments are to a large extent rooted in the physical structure and function of our brains. Our mental functioning is impacted by the behaviors we engage in, our hormones and endocrine system, and the foods and toxins we take in. Molecules that are ingested or produced by the body cross the blood-brain barrier to shape brain structure and function. Mental illnesses are increasingly being reframed as brain disorders, and mental health as equivalent to brain health ([Weir, 2012](#)).

However, symptoms of mental illness do not only start in the brain. For example, science is discovering connections between the central nervous system and gut microbiota, referred to as



the gut-brain-axis, which appear to be involved in anxiety, depression, schizophrenia and autism (Clapp et al., 2017). Mental health is increasingly being connected to endocrine and immune pathways as well, with stress having clear effects on hormone and immune function (González-Díaz et al., 2017).

These connections between mental health and neurological, endocrine, immune systems and other systems are bidirectional. In other words, our physiology affects our mental and emotional states, and our mental and emotional states and attitudes affect our physical health. It is a two-way street. How we think and feel affects the health of our bodies. Patterns of thinking, stress levels and emotions, and behavior over time affect our brains, hormones and immune systems. Even single-event psychological traumas can affect our physiology in long-lasting ways – particularly in childhood but also in adulthood. The good news: changing our patterns of thinking, feeling, and behaving for the better, sometimes in simple yet profound ways, can also improve our physiology.

### **Lack of Exercise and Sedentary Behavior are Prevalent**

Sedentary behavior (waking time spent sitting or reclining without being otherwise active), is highly prevalent among the U.S. population. Younger adults sit over 9 hours per day on average, a number that represents the largest increase in sedentary time and the largest decrease in moderate to vigorous physical activity over the previous decades compared to other age groups. Sedentary time negatively influences mental health, increasing risk for anxiety, depression, and lower emotional well-being. Reductions in sedentary time, even just 60 minutes a day, positively influence mental well-being (Ellingson et al., 2018).

In those experiencing symptoms of mental illness, lack of exercise is even more prevalent. In part due to lack of physical activity, research shows that people with serious mental illnesses experience increased diabetes, heart disease, obesity and a reduced life-expectancy of up to 25 years (Stanton & Happell, 2014).

Reducing sedentary behavior and increasing physical activity is a challenge, because as Firth and colleagues (2016) point out “Many of the desirable outcomes of exercise for people with serious mental illness, such as mood improvement, stress reduction and increased energy, are inversely related to the barriers of depression, stress and fatigue which frequently restrict their participation in exercise.” A meta-analysis of motivating factors and barriers for exercise among people with severe mental illness showed that “the most common motivations were ‘losing weight’ (83% of patients), ‘improving mood’ (81%) and ‘reducing stress’ (78%). However, low mood and stress were also identified as the most prevalent barriers towards exercise (61% of patients), followed by ‘lack of support’ (50%)”. In other words, as symptoms that would benefit from increased exercise increase, ability or motivation to exercise decreases. Because of this, recommendations for exercise, physical activity, or movement for people experiencing mental illness symptoms will have limited effectiveness unless accompanied by evidence-based support for behavior change.

## Exercise, Physical Activity, and Movement Benefit Mental Health

Exercise, physical activity, and movement are associated with improved mental health. A Centers for Disease Control and Prevention survey of 1.2 million adults found that the number of days they reported having poor mental health (which averages 3.4 days per month in the general population) were 42% lower among those who reported exercising in the past month. This effect was even stronger in people with a previous history of depression. In addition, prospective studies show that even low levels of physical activity, such as walking a few hours a week, are associated with reduced risk of developing depression ([Mammen & Faulker, 2013](#)).

Because they are correlational, these associations do not necessarily prove that exercise and physical activity cause improvements in mental health. Symptoms of mental illness and side effects of psychiatric medications often reduce motivation to exercise, and it is possible that other factors, such as high stress, trauma, and social disadvantages cause reductions in both mental health and exercise.

However, multiple clinical trials indicate that physical activity interventions do exert a beneficial effect on mental health symptoms. Let's take depression as an example. A meta-analysis of 39 trials indicated a large effect of physical activity interventions (not just correlations) on reducing symptoms of depression and schizophrenia, as well as moderately improving quality of life among those with mental illness ([Rosenbaum et al., 2014](#)). A clinical evidence synthesis in the Journal of the American Medical Association (JAMA) that also included 39 trials found that exercise is associated with reductions in symptoms of depression when compared with no treatment, placebo, or active controls such as meditation or relaxation. Resistance training and aerobic exercise both showed moderate antidepressant effects, with resistance training being showing the larger effects of the two. Another meta-analysis including 25 randomized controlled trials on exercise as a treatment for depression concluded that exercise had a large and significant effect on depression, including major depressive disorder, especially when exercise was moderate intensity, aerobic, and supervised by exercise professionals ([Schuch et al., 2016](#)). Notably, this meta-analysis controlled for publication bias (taking into account the file-drawer effect, in which some studies that do not show effects are not published), estimating that over a thousand negative studies would need to be completed and unpublished to nullify the conclusions of the meta-analysis. The authors concluded that publication bias actually led to the scientific literature underestimating the strength of the effect of exercise on depression.

There has been some debate in the literature about the strength of the evidence for exercise as a treatment for depression, and not all clinical trials have shown an effect of exercise on mental health outcomes. The JAMA meta-analysis referenced above reported that when only the most stringent study designs were included, the overall effect of exercise on mental health outcomes was small. However, a re-analysis of the same dataset with what the authors called a more rational approach revealed that the effect of exercise on reducing depression symptoms was actually large. In fact, the authors point out: "exercise groups lowered their depression scores more than the control groups by 6.43 units on the Beck Depression Inventory and by 4.07 units on the Hamilton Rating Scale [45]. Perhaps more importantly, the seven studies that included head-to-head comparison to psychotherapy (N = 189) and the four studies that included

head-to-head comparison to antidepressants (N = 300) showed that the benefits from exercise were not different from either (SMD = -0.03, 95% CI -0.32 to 0.26,  $I^2 = 0.0%$ , and SMD = -0.11, 95% CI -0.34 to 0.12,  $I^2 = 0.0%$ , respectively)." (Ekkekakis & Murri, 2017).

A meta-analysis of six trials concluded that exercise is more effective than control conditions in improving anxiety symptoms in people with a current diagnosis of anxiety and/ or stress-related disorders (Stubbs et al., 2017). Another meta-analysis of nine trials showed that exercise was effective for "clinically raised anxiety," with higher intensity exercise appearing to be superior (Aylett et al., 2018). It appears across studies that effects of exercise are stronger for depression, particularly over time. For example, one meta-study of 37 meta-analyses with over 40,000 people found that the average effect on reducing anxiety symptoms was significant, but smaller than the effect of exercise on depression (Wegner et al., 2014). However, it is important to note that a growing body of research indicates that exercise can provide acute relief, or reductions in anxiety immediately after an exercise session, which may serve as an in-the-moment coping mechanism (Ensari et al., 2015).

While most studies have been done on exercise and depression, evidence indicates that aerobic physical activity can reduce psychiatric symptoms and improve cognition in schizophrenia-spectrum disorders. Less research exists for effects of exercise in the treatment of bipolar disorders.

Movement interventions such as tai chi, qi gong, yoga appear to have robust positive effects on depression and anxiety, as evidenced by this excerpt from a recent review by Yeung and colleagues (2019) on Tai Chi and Qi Gong

"...a 2009 review of Tai Chi and Qigong in older adults, examined 36 clinical trials with a total of 3799 participants and concluded that Tai Chi and Qigong practice led to significant improvements in depression and anxiety. These findings are further strengthened by a 2012 article by Lee and Ernst which consolidated 35 systematic reviews (SRs) to identify the evidence for the effectiveness of Tai Chi on different areas of health. Of these SRs, six examined the effect of Tai Chi on psychological health and well-being, with the majority showing positive results. In one SR, Wang et al. found that 17 randomized controlled trials showed that Tai Chi had a positive effect on psychological well-being and reduced anxiety and depressive symptoms. In another systematic review (Berghmans et al., 2009), 47 randomized controlled trials were assessed, showing that there is a positive correlation between Tai Chi practice and an improvement in psychological well-being, including reductions in anxiety and depressive symptoms. Three other SRs with relatively small samples of randomized controlled trials also showed an improvement of psychological well-being, including a reduction in depressive symptoms, associated with conducting Tai Chi." (pg. 217)

In a meta-analysis of 19 studies of patients with depression, post-traumatic stress, schizophrenia, anxiety, alcohol dependence and bipolar disorder, yoga showed greater reductions in depressive symptoms than waitlist, treatment as usual and attention control, with greater reductions in depressive symptoms being associated with higher frequency of yoga sessions per week. Another meta-analysis of 25 studies (Klatte et al., 2016) reported a large and significant effect of yoga on symptom severity when compared to untreated control groups, and small but significant effects when compared to attention control and physical exercise. This study found no difference in efficacy between yoga and standard psychotherapy. Finally, a systematic meta-review of 13

literature reviews ([Macy et al., 2018](#)), examining a total of 185 distinct studies on yoga for post-traumatic stress concluded that “the evidence regarding yoga as an intervention for the effects of trauma as well as the mental health symptoms and illnesses often associated with trauma is encouraging but preliminary.”

Across the studies included in this scoping review in addition to other meta-analyses and systematic reviews in the scientific literature, with very few exceptions (such as treatment of positive symptoms in schizophrenia or bipolar disorder) it appears clear that exercise and physical activity benefit mental health and are useful in treating mental disorders. Few null or negative results were reported, and the remainder of studies reviewed range from exercise interventions in mental health outcomes being promising or encouraging, moderately reducing symptoms, or ready to be translated into clinical care as evidence-based treatments (such as aerobic and resistance exercise for depression and anxiety). Benefits of exercise and other forms of movement on mental health appear to be maximized when exercise is moderate to vigorous, engaged in several times per week, and higher intensity or paired with resistance training.

In many domains, it is time to proceed from exploratory research to rigorous randomized controlled trials. In others the field is justified in moving from multiple isolated randomized controlled trials with varying interventions and outcomes to standardized pragmatic effectiveness trials in real-world settings, including examination of what patient or disorder characteristics can be matched with which types and doses of exercise and movement. Overall, we conclude that exercise and movement can now be considered mainstream elements of mental health care, as opposed to optional complementary or alternative modalities.

## How Might Exercise Improve Mental Health?

Exercise and physical activity are the most impactful health behaviors for sustaining the functioning of our hearts, lungs, muscles, and immune systems. It is not surprising that both animal and human studies from the past 30 to 40 years clearly show that exercise and physical activity benefit the brain as well, eliciting both functional and structural changes, and boosting neuroplasticity – or the brain’s ability to “rewire” itself for better learning, memory, and cognitive function. In adolescence when the brain is developing rapidly, research indicates ([Belcher et al., 2020](#)) that physical activity, exercise, and aerobic fitness may facilitate psychological resilience through strengthening individual brain regions as well as large-scale neural circuits to improve emotion and behavior regulation – both essential components of lifelong mental wellness.

As treatments for mental illness and fostering of mental health, exercise and physical activity appear to exert their effects through several biological and behavioral pathways. [Zhao and colleagues \(2020\)](#) review of the literature concluded that:

“Exercise has a positive effect on brain plasticity in patients with depression. It can rebuild brain structure, activate related brain regions, and promote adaptive changes in behavior; it also has a positive effect on maintaining hippocampal volume and white matter volume integrity, thus improving brain nerve processing efficiency and delaying degradation of cognitive function. The neuroprotective and brain activation effects of exercise have been revealed from a mechanistic perspective.” (p. 892).

The neurochemicals, brain function and structure affected during exercise overlap with those responsible for depression and anxiety, which provides strong evidence that exercise-induced effects on these neurochemicals and structures induce protection or relief from depression and anxiety. However, more human studies are needed that use rigorous designs that will allow us to go beyond correlational findings to more definitively identify effects of exercise in the brain and body that are most relevant to its therapeutic benefit.

A leading theory is that exercise increases the availability of neurotransmitters and neurotrophic factors connected with mental wellness, including brain-derived neurotrophic factor (BDNF) (Heyman et al., 2012) dopamine, glutamate, norepinephrine, serotonin (all neurotransmitters), and endocannabinoids. The endocannabinoid system (Aizpurua-Olaizola et al., 2017) is responsible for regulating and balancing many processes in the body, including immune response, communication between cells, appetite and metabolism, memory, and more. It was named after cannabis (marijuana) when scientists studying the effects of the plant discovered an important set of naturally occurring molecules and receptors in the body. Studies indicate (Schuch et al., 2016) that exercise increases brain peptides (chains of amino acids in brain cells) and BDNF, which helps the nerves to transmit signals faster. Aerobic exercise appears to decrease thiobarbituric acid-reactive substances (TBARS) in severely depressed inpatients, important since in one study, examining seven biomarkers, TBARS was the best predictor of bipolar and major depressive disorders, atypical depression, melancholia and current suicidal ideation. Evidence in both animal and human studies (Voss et al., 2013) supports exercise increasing neurogenesis (Liu & Nusslock, 2018), as new neuron form in the brain, and changing brain structure (Jonasson et al., 2017), such as increases in hippocampal volume.

Potential mechanisms (Marcos de Souza Moura et al., 2015) for exercise reducing stress and anxiety also include increasing neurotransmitters noradrenaline and 5-HT, and expression of 5HT<sub>1A</sub> and 5-HT<sub>2C</sub> receptors in the limbic system, all of which are “feel-good” aspects of the brain targeted by anti-anxiety medications. Another possible mechanism is that exercise down-regulates the hypothalamic-pituitary axis (HPA), which is one of the body’s primary stress systems, by increasing the peptide hormone atrial natriuretic peptide (ANP) which inhibits the HPA. Exercise also appears to reduce how much and how long cortisol (the body’s primary stress hormone) floods the system after people are exposed to a stressor. More research on the biological mechanisms by which exercise might improve mental health are needed.

Exercise and physical activity improves mental health through a number of psychological and behavioral pathways as well. Anderson and Shivakumar (2013) note that:

- Exposure to physical training may increase tolerance and decrease sensitivity to discomfort. Engagement with exercise may lead to an increased sense of self-efficacy as patients see an increase in their ability to cope with the physiological challenges of exercise.
- Patients with anxiety disorders tend to withdraw from social situations and engaging in [group] exercise represents a change in social behaviour.
- The Distraction Theory posits that exercise may provide “time out” from daily activities and decrease anxious rumination, allowing the patient to think anxiety thoughts instead.

Outdoor exercise adds the benefits of nature, fresh air and sunshine to boost mood. Exercise with others increases social support. And, feeling more fit, mobile and physically balanced over time may improve overall well-being and quality of life.

Finally, exercise may not only improve psychological symptoms, but could also mitigate the higher risk of disease and mortality people with mental illnesses face. People with mental illnesses die a median of 10 years sooner than those without. Exercise could help address this “mortality gap” by reducing/managing weight gain, increasing sleep quality and duration, increasing cardio-respiratory fitness, reducing inflammation, and improving stress reactivity (Murri et al., 2019).

## **Purpose of the Report**

Because the scientific literature on exercise/physical activity/movement and mental health outcomes is large and can be difficult to navigate, the purpose of this project is to 1) identify as many published scientific articles on the topic as possible, 2) provide an overview of and access to articles in each category of exercise stratified by type of exercise and mental health outcome, 3) summarize the proportion of articles with significant results in each category, 4) describe trends across the results of each category and in the overall literature, and 5) provide an accompanying online data visualization that allows viewers to quickly grasp and explore the existing data in their categories of interest.

Our intention is for this report to serve as a resource for mental health professionals, educators, clinic directors, policy makers, patients and families to assess the evidence for various forms of exercise, physical activity and movement for mental health. We hope it helps readers identify activities and interventions that hold promise for their situation or setting, and learn what factors can support integration of evidence-based activities into treatment, early intervention and prevention efforts. We also intend that this report highlight which types of physical activity hold the most promise for which mental health outcomes, and which do not appear to be helpful. Finally, this report is a preliminary step in identifying gaps in evidence, limitations of current research, and the most promising research directions for future funding decisions by the JWB Foundation, our partners and other funding agencies.

## **Limitations of this Report**

This is a scoping review and broad evidence map, as opposed to a systematic review or meta-analysis. Scoping reviews seek to present an overview of a potentially large and diverse body of literature pertaining to a broad topic, whereas systematic reviews attempt to collate empirical evidence from a relatively smaller number of studies pertaining to a focused research question. This report and its associated tables should be considered a broad overview, designed to serve as a tool to navigate the literature.

As such, this review did not evaluate the quality of design or strength of the evidence for each study, and therefore includes multiple studies that may have weak designs, be underpowered, or have evidence inadequate to the conclusions drawn. Please use this report as a portal to being able to access and further evaluate the quality and strength of relevant articles.



See [here](#) (Physiotherapy Evidence Database) for criteria you might use to help you evaluate a clinical research trial, or [here](#) (Plant Based Research) to learn more about reading and interpreting research articles.

Only articles in English were included in this review, which leaves out potentially important findings from research reported in non-English languages.

We did not conduct an analysis of publication bias or the “file drawer effect.” This occurs when authors are more likely to submit, or editors are more likely to accept, positive results than negative or inconclusive results. The question is: how many studies were not published or left in the “file drawer” because their findings were not what the researcher expected, or were not considered interesting enough to publish? It is possible that articles reporting a positive relationship between exercise/physical activity and mental health are overrepresented, and articles reporting on negative or null results are underrepresented in the published literature and therefore, in this report.

Finally, while a concerted effort was made to include all identifiable articles focusing on exercise/physical activity and mental health as of November 15th, 2020 using a comprehensive search string, it is likely to have missed relevant articles. If you wish to suggest a correction to this report, or an article is missing that you suggest be included, please nominate it for inclusion at [info@johnwbrickfoundation.org](mailto:info@johnwbrickfoundation.org), and we will review and include it if appropriate in our ongoing updates.

## Definitions

### Exercise and Physical Activity

**Physical Activity:** [Caspersen and colleagues](#) (1985) define physical activity “as any skeletal muscle movement that results in energy expenditure.” Physical activity can be completed at home when completing household activities (from vacuuming to walking to the fridge), at work, at leisure, or during sports, as examples.

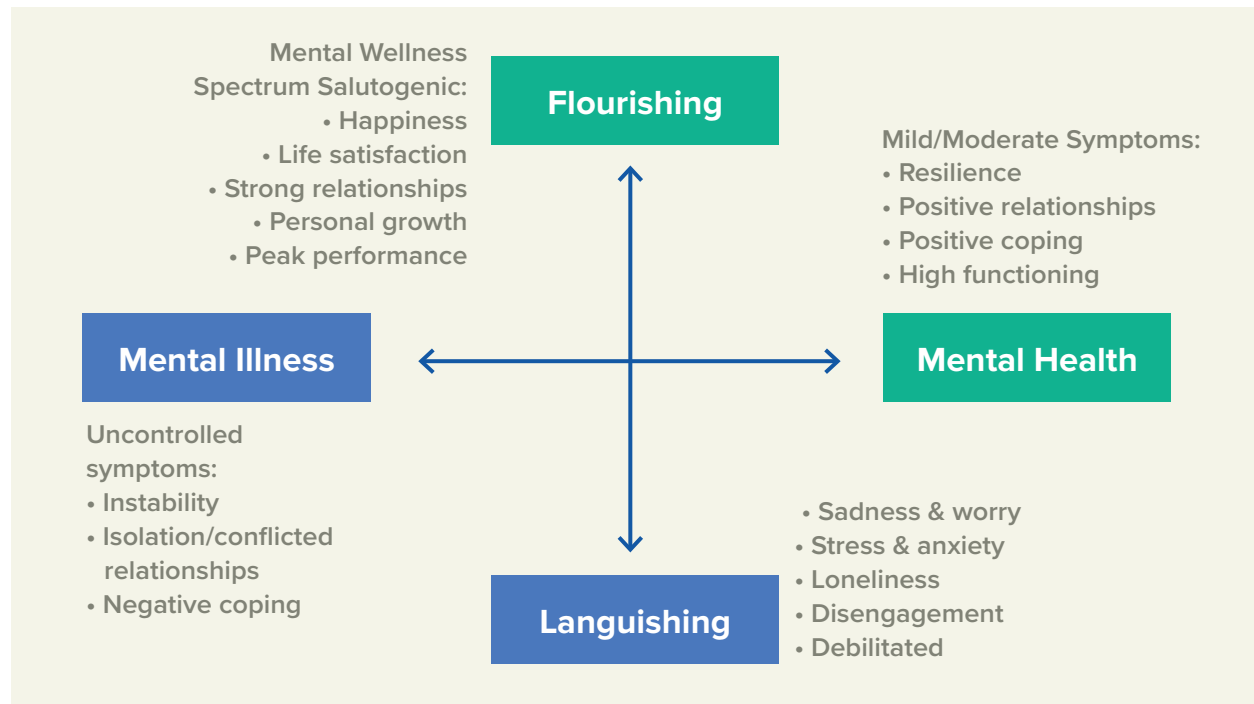
**Exercise:** On the other hand, exercise is planned, deliberate, and repetitive physical activity with the purpose of improving physical fitness. Exercise is a type of physical activity. In this report exercise is defined as all forms of exercise and movement activities, such as aerobic exercise, weight training, tai chi, qigong, yoga, cycling, dance, hiking, etc. (see complete list in the table of contents).

**F.I.T.T.:** Exercise and physical activity are often measured in terms of Frequency (how often), Intensity (how much exertion), Type (what kind of exercise or physical activity), and Time (how long) of physical activity and exercise, now referred to as F.I.T.T..

**Fitness:** Fitness is a “set of attributes that people have or achieve” both in terms of health and “skills that pertain to athletic ability” ([Caspersen et al., 1985](#)). For the purpose of this review, we focus on the health-related components of physical fitness, and according to Caspersen and colleagues, these are: “(1) cardiorespiratory endurance, (b) muscular endurance, (c) muscular strength, (d) body composition, and (e) flexibility.”

## Mental Health and Mental Wellness

**Mental Health:** Throughout this report, mental health refers to general mental and emotional functioning. Mental illness refers to symptoms of or diagnosed mental disorders. At the John W. Brick Mental Health Foundation, we use an adapted version of the Dual Spectrum approach developed by the [Global Wellness Institute \(2020\)](#), which proposes adding a dimension of mental wellness. Mental health and mental illness can be viewed as a horizontal continuum. That spectrum includes general contentment and emotional well-being at one end; mental health issues like mild depression and anxiety in the middle; and extreme forms of mental illness, like deep depression, psychosis, panic disorder, schizophrenia and even suicide at the other end.



Note: Adapted from the Global Wellness Institute model, which was developed from concepts originally contributed by [Keith Tudor \(1996\)](#) and [Corey L.M. Keyes \(2007\)](#).

**Figure 3:** Dual Continuum Model of Mental Wellness

However, there is another spectrum of high and low mental wellness. High mental wellness refers to a level of overall mental and emotional thriving – including positive outlooks, meaningful relationships, self-care, and engagement with life. Low mental wellness is defined by a general languishing – characterized by disruptive amounts of worry, stress, loneliness, lack of self-care, and disengagement. This added vertical axis captures the reality that people with mental illness or diagnosed mental disorders can experience mental wellness – such as life satisfaction, strong relationships, personal growth – with the right support, tools and practices. And people without symptoms of mental illness or a diagnosed mental disorder can experience low emotional and mental wellness – such as overwhelming stress, loneliness and conflict – at times.



## Research

**Peer-Reviewed Publications:** In this report when we mention articles, studies, or peer-reviewed publications we mean reports of scientific research findings that have been published in the peer-reviewed academic literature. This means that they have followed certain reporting guidelines and formatting conventions, have been reviewed by typically at least two other scientists or scholars, and have been accepted by a journal editor. There is a wide-range of quality in articles, studies, and peer-reviewed publications – some journals are highly competitive and cited often, while others have a lower bar for publication and are more obscure. The purpose of this report was to gather and seek patterns across all the existing research, so the articles and journals will be of varying quality.

**Systematic Review:** A systematic review is a review of the evidence using systematic and explicit methods to identify, select and critically appraise relevant primary research, and to extract and analyze data from the studies that are included in the review. These typically summarize or search for patterns across multiple studies, using strict criteria for which studies are included.

**Meta-Analysis:** A meta-analysis is a method of quantitative review, in which statistical analysis is applied to the results of at least two (though, usually more) similar articles to evaluate effectiveness of an intervention ([Ahn & Kang, 2018](#)). Statistical meta-analysis is reported and usually carried out in systematic reviews of studies. A narrative review is a more informal article where one or more authors is either summarizing or making a point about a body of research, without specific selection criteria for which articles they include. These can be more interesting to read, but also more biased.

**Scoping Review:** A scoping review ([Munn et al., 2018](#)) is a tool to determine the scope or coverage of a body of literature on a topic and give clear indication of the number of studies available, as well as providing an overview of the topic. It is designed to:

- identify the types of available evidence in a given field;
- clarify key concepts/ definitions in the literature;
- examine how research is conducted on a certain topic or field;
- identify key characteristics or factors related to a concept; and
- help to identify and analyze knowledge gaps.

**Clinical Trial/RCT:** A randomized clinical trial ([Kabisch et al., 2011](#)) describes a study in which participants are divided by random chance into separate groups. These separate groups receive different treatment interventions and are then compared to each other. Randomization is used to divide participants into groups in a way that reduces bias and increases similarity of the groups. This is done to isolate effects of the different treatments and therefore compare outcomes of the interventions more fairly. RCTs will usually include one of these groups assigned as a control group (therefore naming RCT as ‘randomized controlled trial’). This control group may be administered a placebo or receive no intervention at all and is used as a standard to compare the outcomes of the intervention group vs. control group. RCTs, due to their characteristics as an evidence-based approach, are considered the gold standard for determining efficacy of treatments in clinical research.

**Qualitative Study:** Qualitative research ([Pathak et al., 2013](#)), contrary to quantitative research which is based in numbers and objective methods, is an assessment of non-numerical data. This type of research is used to understand people's experiences, attitudes, behavior, interactions, and beliefs, and is therefore more subjective and humanistic in nature. Qualitative research includes observational studies, interviews, and textual analysis. Though not seen as objective as quantitative data, qualitative research has its merits in that qualitative data can help understand and view human behaviors more extensively and provide greater understanding of health related issues.

**Pilot/Development Study:** Pilot studies ([Leon et al., 2011](#)) are critical foundations in the research process to determine feasibility and development of an approach that may be applied to a larger-scale study. Pilot studies can be conducted to evaluate efficacy of various characteristics of clinical studies, such as recruitment, randomization, methodology, procedures, and implementation of interventions. Pilot studies usually are small-scale in nature, and focus on establishing feasibility of treatment or research methods, testing whether a treatment approach is acceptable to the target population, or assessing the initial promise of an intervention.

**Pre-Post Study:** Pre-post studies ([Thiese, 2014](#)) are one type of experimental study design that measures an outcome before and after the implementation of an intervention of interest. These studies can look at either a single group measured before and after an intervention (sometimes called a within-subjects design) or compare outcomes between multiple groups (known as multiple arms). An example of a pre-post study design would be one comparing occurrence of motor vehicle crash deaths before and after enforcement of a mandatory seat-belt law, the enforcement of the law being the intervention of interest. Analytic methods of these types of studies depend on the type of outcome being measured and the number of treatment groups involved for comparison.

**Longitudinal Analysis:** As the name implies, longitudinal studies ([Caruana et al., 2015](#)) consist of repeated measures data collection following participants over prolonged periods of times, upwards of years or even decades. Longitudinal analyses can provide both quantitative and/or qualitative data and are often observational in nature. This type of study involves data collected for a certain number of individuals within a predetermined group and therefore is useful for applying statistical testing to analyze change over time and evaluating relationships between risk factors and health outcomes. A representative example of a longitudinal study in medical research is the Framingham Heart Study, which included an original cohort of 5,209 subjects that were recruited and followed up for 20 years.

**Cross-sectional/Correlational Analysis:** A cross-sectional study ([Setia, 2016](#)), similar to longitudinal analysis, is observational by nature. The difference however is related to the time point in data collection. Cross-sectional studies compare different population groups at a single point in time, rather than over a prolonged period of time. A cross-sectional study design, therefore, can allow researchers to compare many different variables across groups at the same time. These data may not be able to provide information about causality in relationships, due to the single time-point of data collection, however they are valuable in providing correlational evidence between outcomes and exposures.

**Effect Size:** Effect size (Lippink, et al., 2016) is a quantitative measure of the magnitude of an experimental effect – for example, how much does aerobic exercise improve depression scores in a group in comparison to a group that is not engaging in aerobic exercise. In this example, the larger the effect size the stronger the relationship between aerobic exercise and depression scores. This is important because in large numbers of subjects, even very small effect sizes can be statistically significant – but may not be clinically significant. Effect sizes are sometimes categorized as small, medium/moderate and large, with a small effect size being roughly the difference between the average height of a 15- and 16-year-old girl in the United States, and a large effect size being more like the average difference in height between a 13- and an 18-year-old girl.

**Statement of Language Inclusivity:** Throughout this report we have done our best to be culturally and gender inclusive, as well as using language that respects people with mental illness or mental health challenges. If we have fallen-short of these intentions in these or other areas of diversity, please do not hesitate to let us know at [info@johnwbrickfoundation.org](mailto:info@johnwbrickfoundation.org).

## Methods

### Eligibility Criteria

Articles were included in the review that were 1) published between January 1, 1990 and November 15, 2020, and 2) reported on the effect or relationship of at least one form of exercise or physical activity on or with at least one type of mental health condition or symptom attributed to mental illness. Studies were excluded if they 1) did not contain at least one physical activity and one mental health outcome, 2) did not yet have published peer-reviewed results, or 3) were not in English.

We used search strings (see Appendix B) including keywords describing various forms of exercise/physical activity (such as ‘physical activity,’ weight training,’ or ‘cycling’) as well as keywords describing mental illness/mental health symptoms and disorders (such as ‘mental illness,’ ‘substance use disorder,’ or ‘bipolar disorder’). In the first part of the search string we included general exercise and physical activity, specific forms of exercise and sports, and movement such as yoga, martial arts, tai chi, and qi gong. In the second part of the search string we included general mental illness and mental health and specific mental disorders. We excluded neurological disorders such as dementia, Alzheimer’s disease, and autism.

### Article Selection

These searches yielded a total of 5,699 articles. The search results were uploaded into Google Sheets and screened for duplicates. Thirteen reviewers screened the articles for inclusion/exclusion by reviewing the titles and abstracts. After excluding duplicates and articles not meeting inclusion criteria above, 1444 articles were included in this scoping review. Each article was individually coded for 1) type(s) of physical activity measured or implemented, 2) mental health issue(s) measured, 3) results being non-significant, neutral/null, or significant; 4) study design, and 5) number of participants.

Exercise Type	Clinical Trial/RCT	Longitudinal Analysis	Before/After Study (No Control)	Cross-Sectional/Correlational Analysis	Pilot/Development Study	Qualitative Study	Total Experimental Articles	Total Systematic Reviews + Meta Analyses	Total Narrative Reviews	Total Articles
Aquatic Activities	10		1	1		1	13	0	1	14
Balance & Functional Exercise	3			1			4	0	0	4
Cardiovascular & Aerobic Exercise	144	6	19	26	8	4	207	25	12	244
Cycling	3		11	2	1	1	18	0	0	18
Dance & Movement Therapy	20		2		3	1	26	3	0	29
Flexibility & Stretching Exercises	7		1				8	0	0	8
Games & Exergames	4						4	0	0	4
High Intensity Exercise	14	1	3	9	2	1	30	5	0	35
Low Intensity Exercise	2	1		2		1	6	1	0	7
Martial Arts	2		1	2			5	0	0	5
Moderate Intensity Exercise	9	1		2	1	1	14	2	0	16
General Physical Activity	173	37	37	132	9	44	423	86	71	580
Pilates	8		1				9	1	0	10
Running & Jogging	5	1	3	2			11	0	1	12
Sports	11	2	2	6		7	28	0	3	31
Strength, Weight & Resistance Training	32	2	5	5	1		45	3	0	48
Tai Chi & Qigong	32	1	5	3	5	2	48	5	2	55
Therapeutic Activities	9	2	2	1			14	0	0	14
Walking	35	1	6	7	4	4	57	3	4	64
Yoga	133	1	25	4	12	13	188	36	22	246
<b>TOTALS</b>	<b>656</b>	<b>56</b>	<b>124</b>	<b>196</b>	<b>46</b>	<b>80</b>	<b>1158</b>	<b>170</b>	<b>116</b>	<b>1444</b>

**Table 1:** Number of Articles Categorized by Type of Study and Type of Exercise/Physical Activity.

In addition, we reviewed 170 meta-analyses and systematic reviews, and 116 narrative reviews to create this report.

## Article Coding

Article coders worked independently, and met once per week to resolve questions or suggest new categories. Provisional physical activity and mental health categories were created based on the screening for inclusion/exclusion of articles, and “general physical activity” and “general mental health” were used as categories where other, more specific categories could not be identified in the abstract. Provisional categories included mental health categories: general mental health, severe mental illness, stress/coping, ADD/ADHD, depression, anxiety, schizophrenia, bipolar disorder, obsessive-compulsive disorder, dementia or Alzheimer’s (included only if there was also another mental health outcome), eating disorders, personality disorders, post-traumatic stress disorder (PTSD), addiction/alcoholism or alcohol or substance use disorders, phobias, general well-being, positive psychology, emotional regulation, quality of life, or ‘other’. New categories were added if they appeared repeatedly during the coding process. When multiple mental health outcomes were listed, we included each of them.

The provisional physical activity categories resulting from the screening process included general physical activity, high intensity, low intensity, walking, running and jogging, swimming, cycling, general cardiovascular or aerobic exercise, strength or weight training, yoga, pilates, tai chi, sports, dance, karate, other martial arts, excessive exercise, and ‘other’. When multiple physical activities were listed, we included each of them. Added categories included moderate intensity, stretching, balance, flexibility, games/play, and therapeutic exercise. We also added aquatic exercises in the swimming category, resistance training in the strength/weight training category, movement therapy in the dance category, and combined karate and martial arts ‘other’ into the martial arts category.

Article coders noted the type of study design in the following categories: qualitative study; pilot or developmental study; cross-sectional or correlational study; clinical trial or randomized controlled trial (RCT); scoping or systematic review; meta-analysis; basic science, laboratory, or animal study; prospective, longitudinal (e.g. follow one group over time); or ‘other’.

We recorded the number of participants in each study and whether or not there was a significant result reported in the abstract. In the first round of coding we marked the article as significant if it reported at least one significant result of exercise on mental health. If not, it was marked as non-significant. In the second round of coding, we specified the relationship to significance and the specific significant, non-significant/null, negative outcomes, or mixed results.

## Results

Results in this report have been organized by type of exercise, and sorted by type or category of exercise in alphabetical order. A data visualization available on the project website (<https://johnwbrickfoundation.org/movementandmentalhealth>) allows you to engage with the results in a bubble chart with your choice of type of exercise and category of mental health outcome.

For each type of physical activity, listed in alphabetical order, we have included a description of the category or type of activity, a brief summary of results, a table or chart with the number of articles that reported a positive relationship between exercise and mental health (exercise associated with greater mental health), a null or neutral (not positive or negative) relationship, or a negative relationship (exercise associated with poorer mental health). Only mental health outcomes with one or more studies were included in these tables and charts.

Each section also includes a link to an online viewable/downloadable spreadsheet including all of the articles for that type of exercise, sorted by mental health outcomes, and listing the author, title, abstract, year of publication, journal, and link to each individual article online.

Note: When more than one mental health outcome was investigated by a single article, a record of that article is duplicated in each mental health outcome section, as well as in the table or figure in the section.

# AQUATIC ACTIVITIES



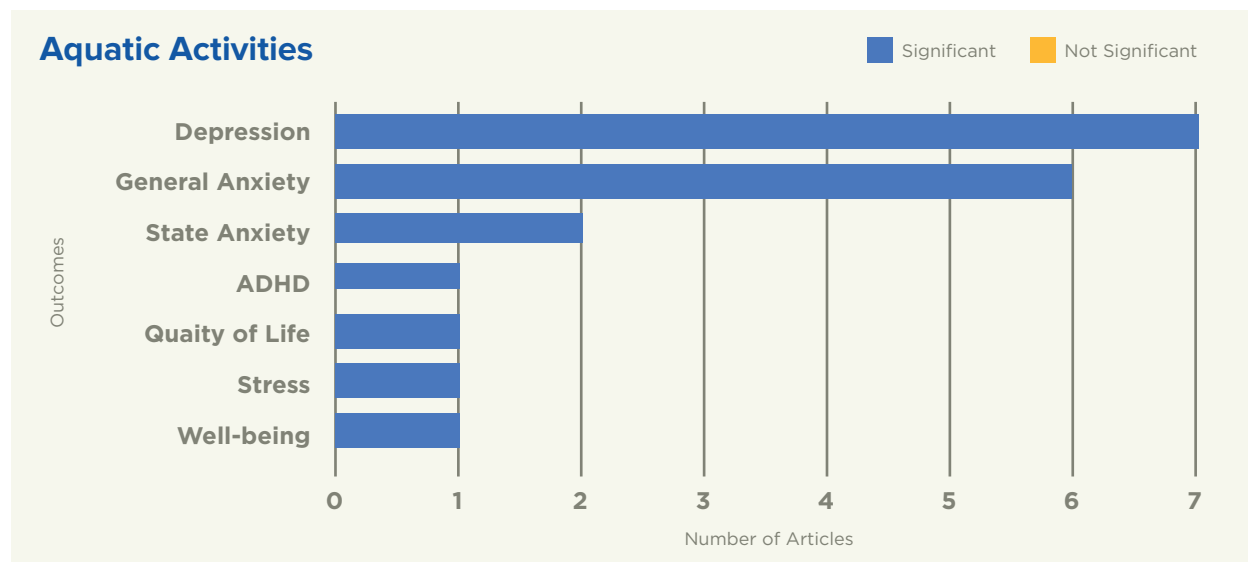
Swimming refers to moving the body by using coordinated movements of the arms, trunk, and legs together to propel the body through water. Aquatic activities is an umbrella term consisting of swimming as well as numerous other activities such as water polo, diving, synchronized

swimming, and more. Though there is a large diversity and variety of aquatic activities, swimming appears to be the most heavily researched (Escalante and Saavedra, 2012).

This category explored the relationship between aquatic activity and various mental health outcomes. A total of 13 peer-reviewed studies were included, and all of which demonstrated benefits of aquatic activity on mental health. Swimming can offer a low-impact form of physical demand, and this opportunity for stress relief appears to benefit individuals struggling with depression (7/13), and anxiety (general 6/13; state 2/13). Aquatic exercise can be utilized as a preventative measure as well; for example, women who engaged in moderate aquatic exercise displayed lower risk of developing postpartum depression than sedentary women (Aguilar-Cordero et al., 2019). Additionally, one representative study found that low-intensity aquatic aerobic training can improve depression and anxiety symptoms, possibly by lowering oxidative stress indicators, which are thought to be related to worse mental health outcomes. This may also be a mechanism of other low-intensity physical activity on improved mental health outcomes (da Silva et al. 2019).

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

Access Aquatic Activities and Mental Health articles included in this [review here](#).



**Figure 4:** Number of significant, not significant, and negative results reported in the Aquatic Activities and Mental Health articles.



## BALANCE & FUNCTIONAL EXERCISES

This category included movement interventions that targeted balance and functionality, primarily for older adults. For example, one study investigated dynamic balance exercises such as standing on one leg, while using a laser pointer for visual feedback (Lee et al., 2020). Specific forms of movement for balance such as yoga, Qi Gong and Tai Chi are included in their own sections. Four peer-reviewed studies examined the relationship between balance exercises and mental health outcomes.

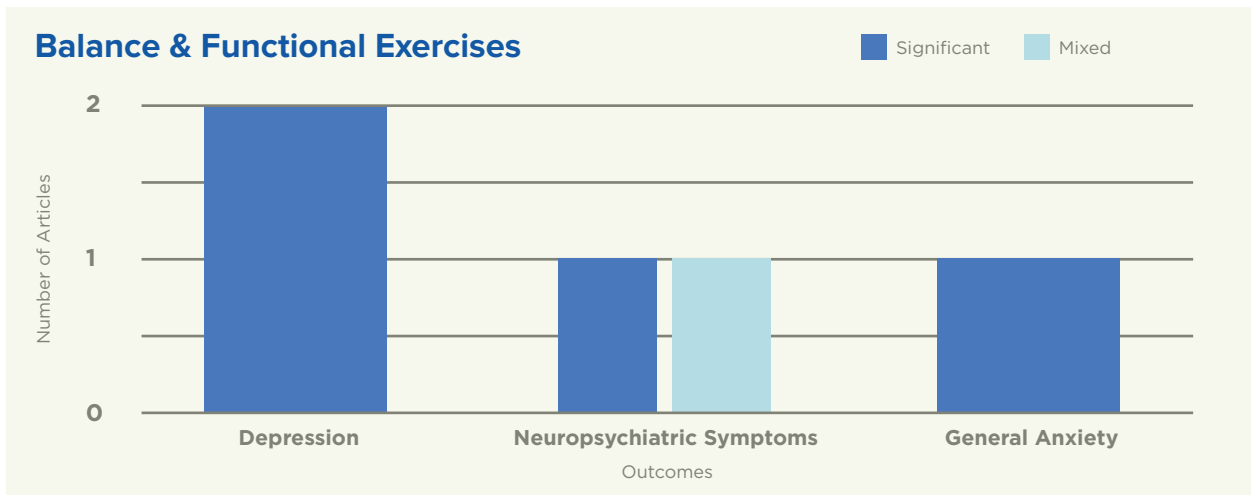


Though studies are few, it appeared that balance exercises hold promise for exerting positive effects on depression, neuropsychiatric symptoms, and anxiety. Beneficial effects of balance exercises were enhanced and longer lasting when they were more challenging, and were combined with strength training. One representative study demonstrated increases in balance and reductions in agitation in older adults lasting 6-months after 12-weeks of twice-weekly high-intensity functional exercise program in comparison to a control group (Telenius et al., 2015).

To what extent these effects are due to physiological mechanisms, or better balance increasing mobility and self-efficacy and therefore mental health, should be a topic of future study. For example, in older adults fear of falling can lead to increased anxiety and decreased overall physical activity (Stubbs et al., 2014), in turn leading to increased risk for depression and other health consequences. It is possible that being able to trust one's balance more improves mental health, but there may be biological pathways to reducing symptoms as well.

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

Find the Balance and Functional Exercises and Mental Health articles included in this [review here](#).



**Figure 5:** Number of significant, not significant, and negative results reported in the Balance and Functional Exercise and Mental Health articles.

# CARDIOVASCULAR & AEROBIC EXERCISE



Aerobic exercise encompasses a wide array of types of movement performed at a moderate to vigorous level of intensity over a period of time. The word aerobic means “with oxygen,” and refers to the circulation of

oxygen through the blood and an increased rate of breathing. Also referred to as cardiovascular, cardiorespiratory, or just “cardio” exercise (cardio = heart), it also creates sustained increases in heart rate. The American College of Sports Medicine defines aerobic exercise ([Garber et al., 2011](#)) as “regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature.” Running, jogging, dancing, rowing, using an elliptical and anything that keeps the breathing and heart rate elevated for a period of time is cardio/aerobic.

This section includes studies that specifically referred to “aerobic” or “cardiovascular” exercise (cycling, running, and other specific exercises that can also be cardio/aerobic are in their own individual sections). We identified 207 peer reviewed articles investigating the relationship between cardio/aerobic exercise and mental health outcomes. Of these, 189 reported a significant relationship between cardio/aerobic exercise and at least one mental health outcome. The remainder showed no effect, and no studies reported negative results.

A majority of the studies on cardio/aerobic exercise focused on depression (139/207). Of these, 125 demonstrated significant associations between cardio/aerobic exercise and lower depressive symptoms.

The dose or intensity of cardiovascular/aerobic exercise required to demonstrate mental health benefits remains in question. One review ([Stanton & Reaburn, 2014](#)) concluded that moderate-intensity aerobic exercise for at least 9 weeks, 30-45 minutes, 3-4 days a week, can effectively treat depression. Another study showed that aerobic interval training intensity of 80% of maximum heart rate (MHR) in a short period of training (10 days) could substantially improve symptoms of depression. And another ([Blumenthal et al., 2007](#)) found that aerobic exercise with intensity of 70%-85% MHR (considered the vigorous zone), 30-minute sessions, three times a week for four months, had a similar effect as an antidepressant. A promising area for future research is investigating what frequency, intensity, duration, and type (F.I.T.T.) of aerobic exercise can reliably benefit mental wellness, and matching F.I.T.T. characteristics to specific symptoms/diagnoses, populations (such as women, elders, or specific ethnic groups), and outcomes (reduction in negative thoughts, increases in energy levels). Having said that, the research across individual studies, systematic reviews and meta-analyses makes it clear that evidence strongly supports recommending moderate intensity cardio/aerobic exercise for alleviating symptoms of depression.

The second most studied cardio/aerobic-mental health outcome was anxiety. Of the 60 studies that evaluated general, state, and/or trait anxiety, 54 reported that cardio/aerobic exercise were significantly associated with reduced anxiety symptoms. Similar to studies on cardio/aerobic exercise on depression, the frequency, intensity, and duration of exercise was widely varied, as were the methods and measures. Taken together however, studies indicate that cardio/aerobic exercise appears to have a beneficial effect on symptoms of anxiety.

Studies also indicate that cardio/aerobic exercise is beneficial for more severe mental disorders. For example, one meta-analysis ([Sabe et al., 2020](#)) including 17 randomized controlled trials with a total of 954 patients revealed a significant beneficial effect of cardio/aerobic exercise on “negative” symptoms of schizophrenia (such as where people appear to withdraw from the world around them, take no interest in everyday social interactions, and often appear emotionless and flat), with aerobic exercise (but not non-aerobic) also reducing “positive” symptoms of schizophrenia (such as hallucinations, delusions, confused thought, and disorganized speech). Another systematic review concluded that aerobic exercise including treadmill walking and cycle exercise undertaken as a supervised group intervention lasting 30 to 40 min per session and undertaken 3 times weekly at moderate intensity for between 10 and 12 weeks appears to be valuable for people with schizophrenia or schizoaffective disorder.

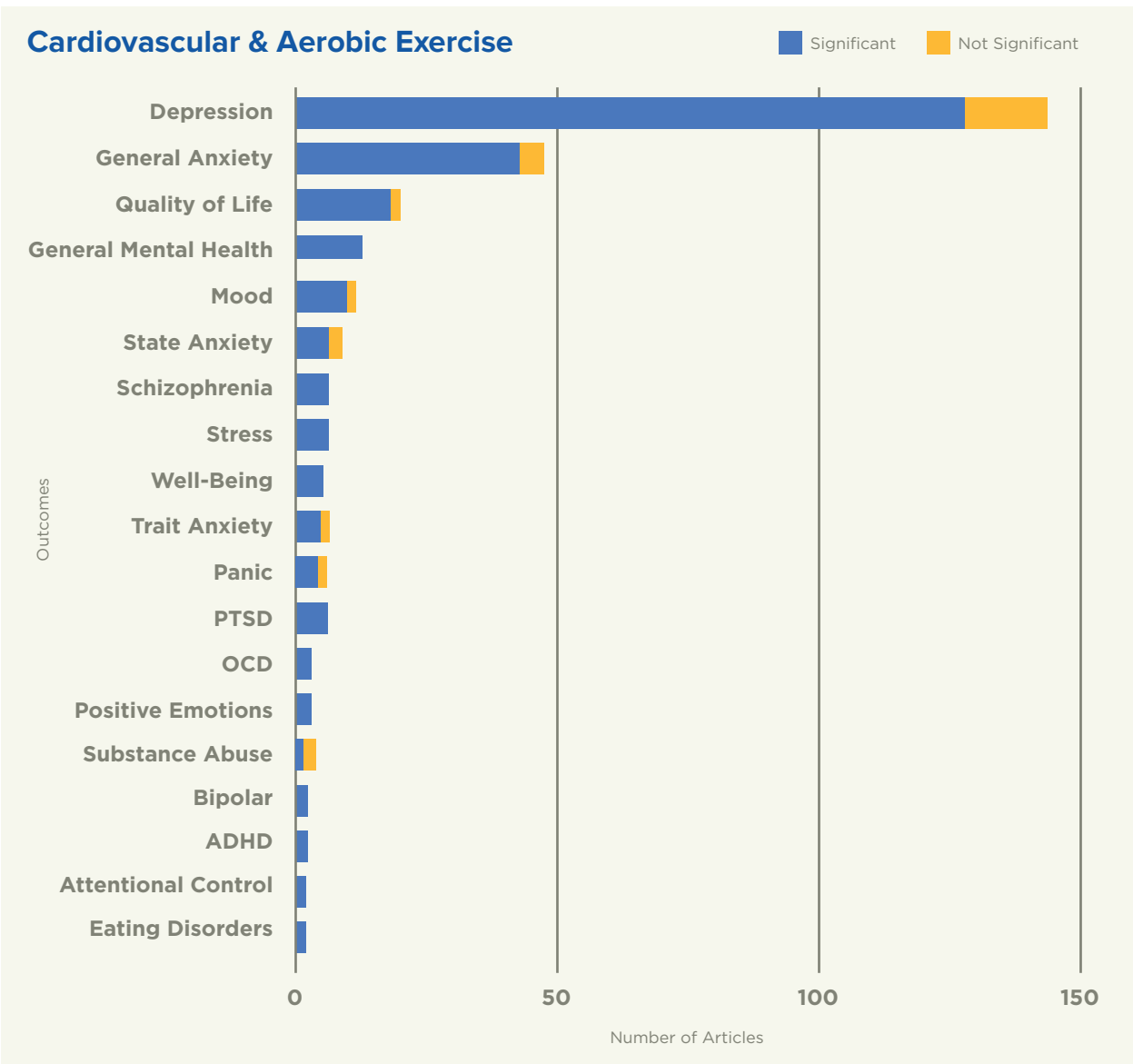
We located 25 systematic reviews and meta-analyses examining the impact of general cardio/aerobic activity on various mental health outcomes. Twenty-three of the included reviews concluded that cardio/aerobic exercise programs significantly improve depression, anxiety, quality of life, schizophrenia symptoms, ADHD symptoms, general mental health, and severe mental illness. A meta-analysis of 39 randomized trials reported that aerobic exercise produced effects comparable to treatment by either antidepressants or psychotherapy ([Cooney et al. 2013](#)). Another meta-analytic study demonstrated that aerobic PA moderately reduced the signs of depression, with populations over 60 years of age and those with mild depression deriving the greatest response ([Silveira et al. 2013](#)).

A meta-review ([Stubbs et al., 2018](#)) that analyzed 20 of the highest quality systematic reviews and meta-analyses on physical activity and serious mental illness concluded:

“Our meta-review supports the use of aerobic exercise of moderate-vigorous intensity at a frequency of 2–3 times a week, ideally supervised by qualified professionals and achieving 150 min of moderate to vigorous physical activity per week in order to improve outcomes in people with Major Depressive Disorder (MDD) and schizophrenia-spectrum disorders. There is also some evidence that a combination of aerobic and resistance training meeting the above frequency, intensity and time criteria can improve outcomes in people with MDD and schizophrenia-spectrum disorders.”

There were also 12 narrative reviews that discussed the relationship between general cardio/aerobic regimens and mental health outcomes. While 50% (6/12) of the narrative reviews focused specifically on depression, others focused on mental health outcomes including general anxiety, schizophrenia symptoms, bipolar disorder symptoms, and general mental health.

To access all articles on cardiovascular and aerobic exercise and mental health, [please see here](#).



**Figure 6:** Number of significant, not significant, and negative results reported in the Cardiovascular/Aerobic Exercise and Mental Health articles.

# CYCLING

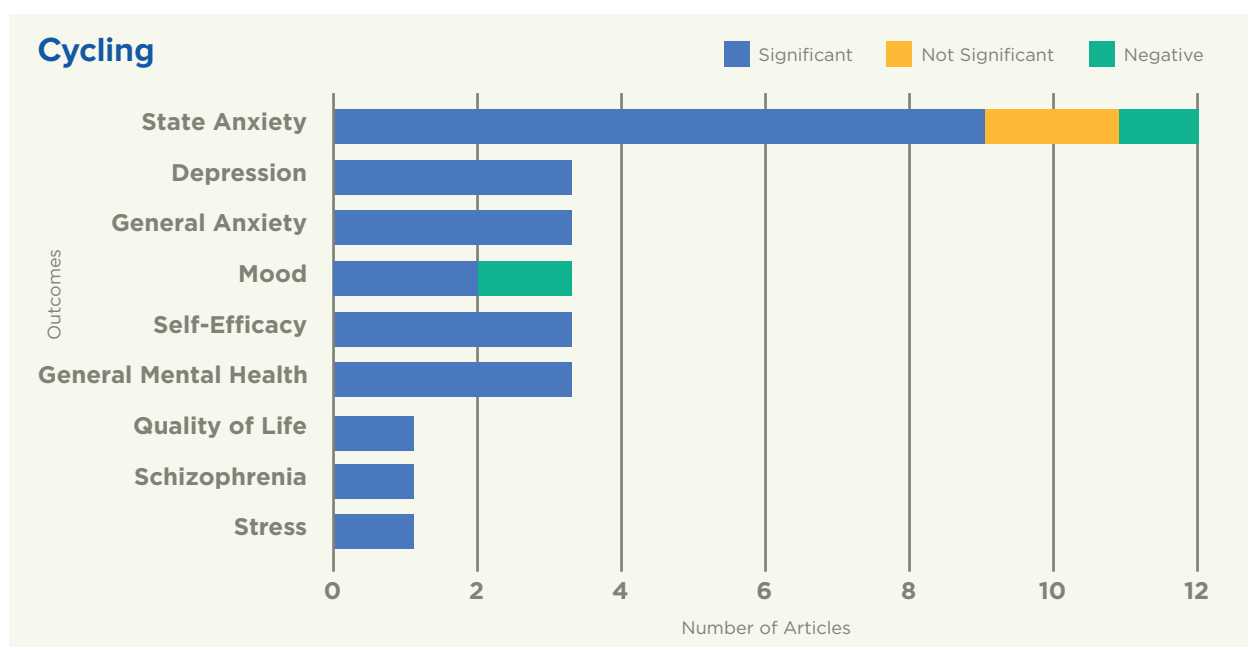
The review identified a total of 18 peer reviewed articles examining the relationship between bicycling and mental health outcomes. Most studies investigated indoor cycling on stationary bikes, with a few investigating outdoor cycling. All 18 articles reported at least one significant mental health related



outcome. A majority (12/18) of the studies investigated the impact of cycling on anxiety (general and state); all of these studies demonstrated significant improvement in anxiety symptoms for participants after engaging in a cycling intervention, with few reporting mixed results. The second most common outcomes researched were depression, mood and self-efficacy. All articles reported that cycling had a significant positive impact on depression symptoms.

A study utilizing virtual reality (Wang et al., 2020) while indoor cycling in people with generalized anxiety disorder, showed that nature imagery vs. art imagery resulted in significantly greater stress-relief, restorative quality, and personal satisfaction. A qualitative study (Schnor et al., 2019) indicated that patients of a community-based mental health clinic who participated in a group-based outdoor cycling program reported benefiting from non-stigmatizing therapeutic relationships in a non-patient environment, outdoor sensory experiences, (e.g., fresh air, wind, and rain) and feelings of personal mastery, equal status, solidarity, community, and healing. No systematic reviews, meta-analyses or narrative reviews on cycling and mental health were identified.

To access the articles on cycling and mental health included in this review, [please see here](#).



**Figure 7:** Number of significant, not significant, and negative results reported in the Cycling and Mental Health articles.



# DANCE & MOVEMENT THERAPY

We identified 26 peer-reviewed articles that evaluated the impact of dance and related movement therapies on at least one mental health outcome. These articles explored a variety of forms of dance including

jazz, ballroom dance, square dancing, bellydance, modern dance, and traditional styles of dance. Also included were articles on dance movement therapy, defined by the [American Dance Therapy Association](#) as the psychotherapeutic use of movement as a process which furthers the emotional, social, cognitive, and physical integration of the individual.

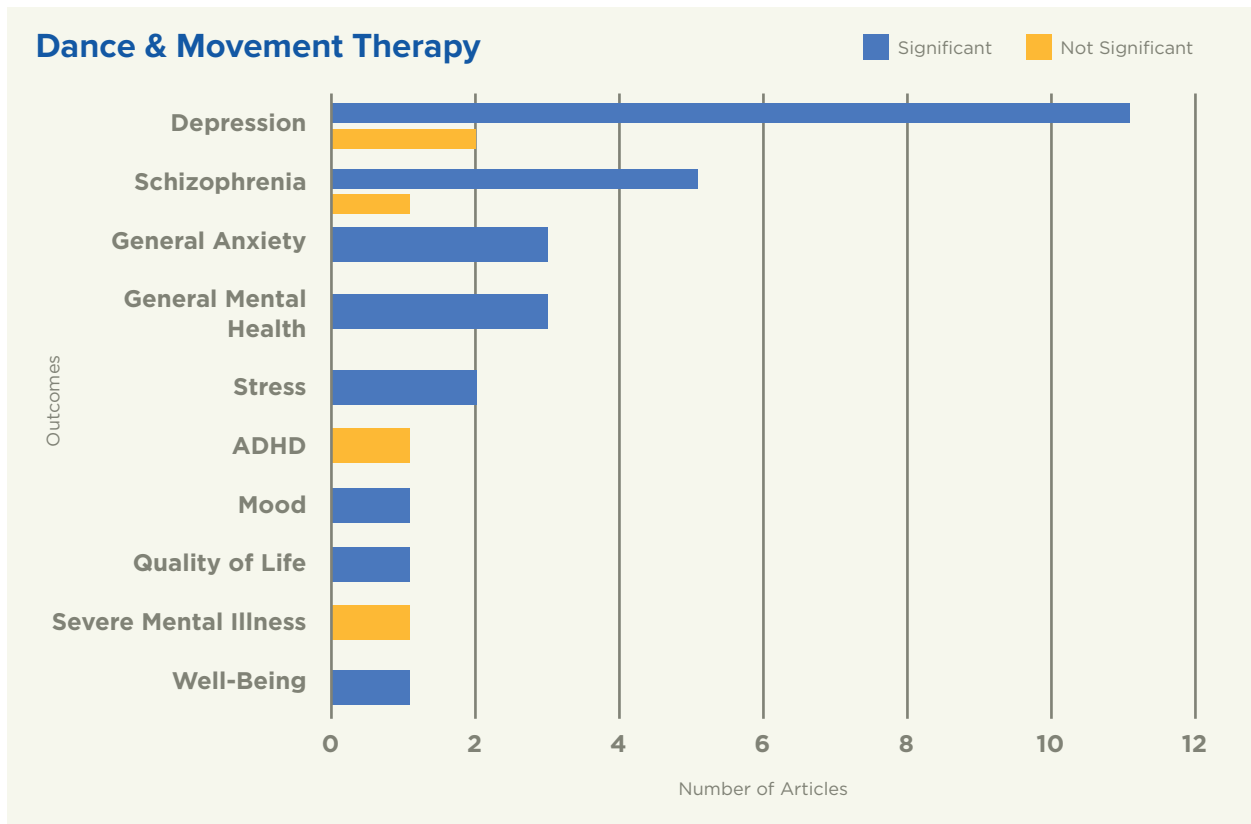
Of the 26 articles, 13 examined depression as the mental health outcome. Out of these, 11 found that dance or movement therapy improved depression outcomes. In one representative study ([Lesté & Rust, 1984](#)), three months of dance therapy significantly reduced anxiety in comparison to three other groups (one exercise, one music, and one mathematics). In another example ([Jeong et al., 2005](#)), in a sample of adolescents with mild depression, 12 weeks of dance movement therapy reduced psychological distress, increased plasma serotonin (sometimes referred to as the “happiness hormone”), and decreased dopamine concentration in comparison to a control group.

Five articles explored the effects of dance or movement therapy on schizophrenia. All five of these five articles revealed at least one positive outcome, and one showed mixed findings (displaying benefits in qualitative reports, but no significant impact on quantitative measures).

Three meta-analyses and systematic reviews were also identified. Two examined schizophrenia, while the third focused on depression as the mental health outcome. All three reported inadequate quality or not enough evidence to either support or refute an effect of dance therapy on mental health outcomes. There is a need for randomized controlled trials with high methodological quality. No narrative reviews were identified for this section of the review.

To learn more about the articles included in this review, please [see here](#).





**Figure 8:** Number of significant, not significant, and negative results reported in the Dance and Movement Therapy and Mental Health articles.



## FLEXIBILITY & STRETCHING

Exercises that improve stretching and flexibility are sometimes used alone, but often are included in multi-component interventions shown to have preventive and therapeutic effects on mental health symptoms (van der Waerden et al., 2013). Our



search yielded 8 peer-reviewed publications that explored the impact of flexibility and stretching exercises (not including yoga) on mental health outcomes. The nature of these flexibility and stretching interventions varied. One study (Sugano & Nomura, 2000), for example, examined land and water interventions, including the common Williams’s extension and McKenzie’s flexion stretching exercises which aimed to improve range of motion in patients that experienced lumbar lower back pain. This study found significant decreases in state anxiety as well as decreases in salivary cortisol concentration, which is an endocrine marker of stress. Another study (Sato et al., 2011) considered a combination stretching-breathing relaxation activity, known as the “Senobi” breathing exercise (SBE), and showed significant effective reductions in symptoms of depression.

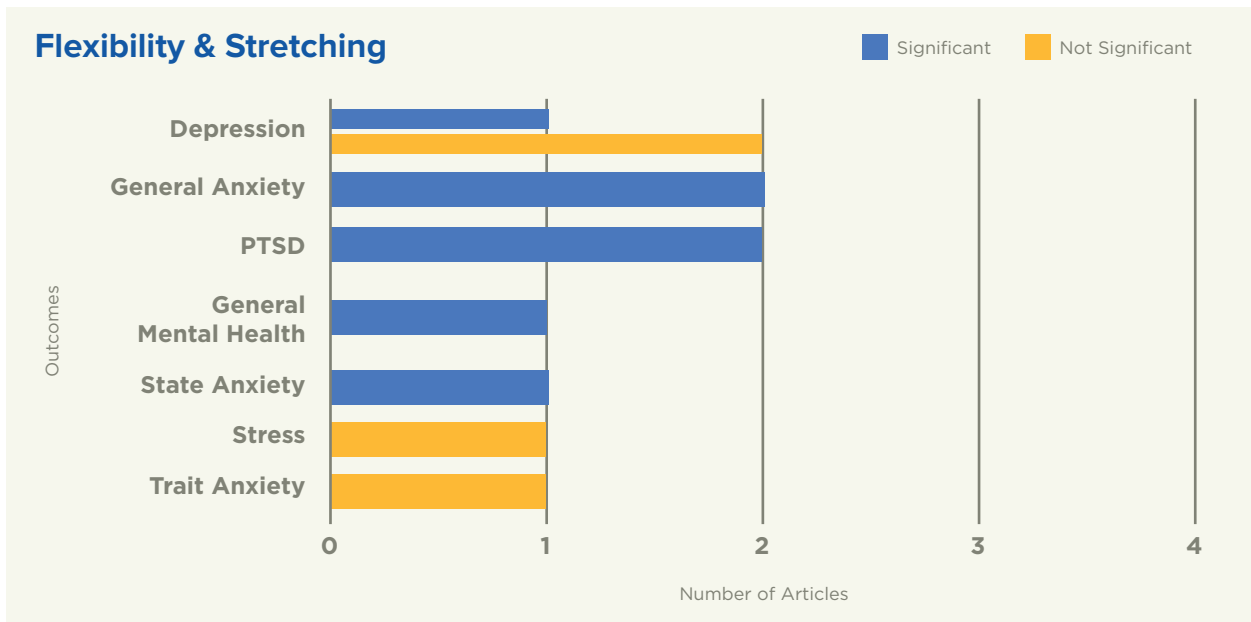
Three articles evaluated depression as the mental health outcome, with two articles reporting null results and the remaining article reporting positive, significant findings between flexibility and stretching exercises and improved outcomes of depression. A possible mechanism for improved symptoms of depression through these stretching exercises, as indicated by one study (Sato et al., 2011), is up-regulation of sympathetic nerve activity and increased secretion of hormones such as catecholamines, 5-HIAA, estrogen, and growth hormone. It is also possible that decreases in pain or increased ease of movement could be responsible for reductions in depression or anxiety.

Two articles focused on flexibility/stretching exercises and general anxiety, with both articles reporting improved outcomes. Two articles evaluating the association of flexibility and stretching exercises on stress and trait anxiety revealed null results.

Three articles showed positive, significant relationships between flexibility and stretching exercises and improved outcomes of PTSD, general mental health, and state anxiety. Those showing significant positive results tended to include breathing regimens, focus on posture and body awareness, and were easy-to-follow, home-based exercises.

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

To learn more about the articles included in this section, please [see here](#).



**Figure 9:** Number of significant, not significant, and negative results reported in the Flexibility and Stretching and Mental Health articles.

# GAMES & EXERGAMES

This section examined activities and exercises that were presented in the form of games or exergames to increase participant engagement, or in situations where participants do not have access or ability to engage in traditional exercise. Exergames

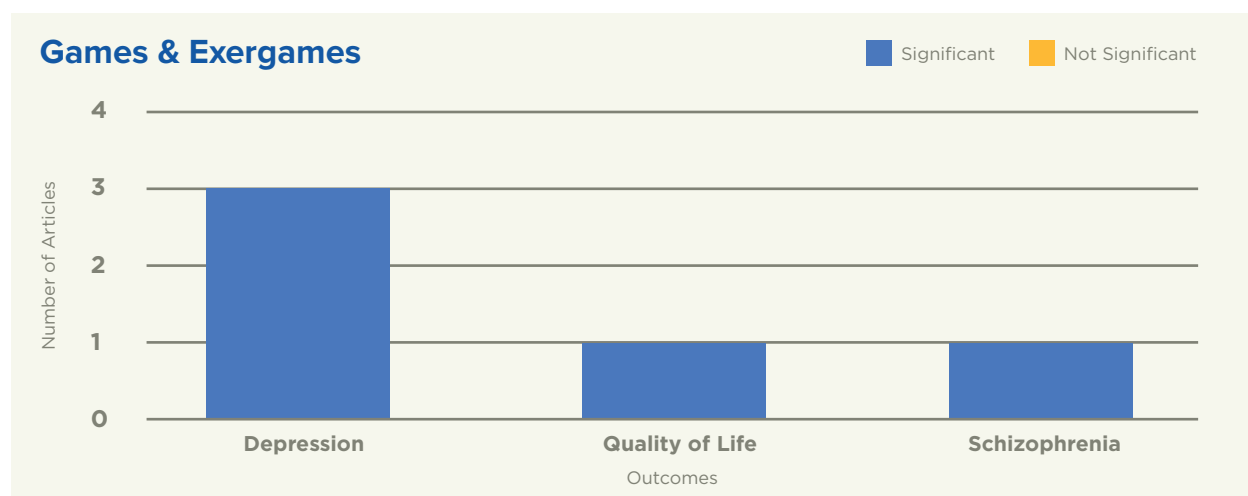


([American College of Sports Medicine, 2013](#)) are technology-driven physical activities, such as video game play, that require participants to be physically active or exercise in order to play the game. We located four studies investigating the impact of games on various mental health outcomes; all of which reported positive results. These focused on depression, schizophrenia, and quality of life outcomes.

One representative study ([Shimizu et al., 2017](#)) showed that frontal lobe blood flow volume (associated with executive functioning) was increased during participation in an interactive sports video game using the Nintendo Wii™ in patients with schizophrenia, along with improvements in quality of life. Another study ([Li et al., 2018](#)) showed that this type of exergame, also using the Wii (™) led to higher positive emotions than traditional exercise in patients with subclinical depression. Still another study ([Zhou et al., 2020](#)) showed that administering exergames virtually, using feedback from wearable movement monitors, was as effective on mental health outcomes including depression and quality of life, as those being supervised in person.

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

Access Games and Mental Health articles included in this [review here](#).



**Figure 10:** Number of significant, not significant, and negative results reported in the Games and Exergames and Mental Health articles.

# HIGH INTENSITY EXERCISE

Various forms of high intensity exercise have been studied, including running, walking, treadmill training, high-intensity aerobic training, high-intensity interval training (HIIT) in which one works at 80-90% of maximum heart rate for brief periods with brief



periods of rest in-between. There is not a precise definition of high intensity, but it is described as being short of breath, being able to say only a few words at a time, or perceived exertion on a scale of 1-10 being rated by participants as an 8 or 9 (Eston, 2012).

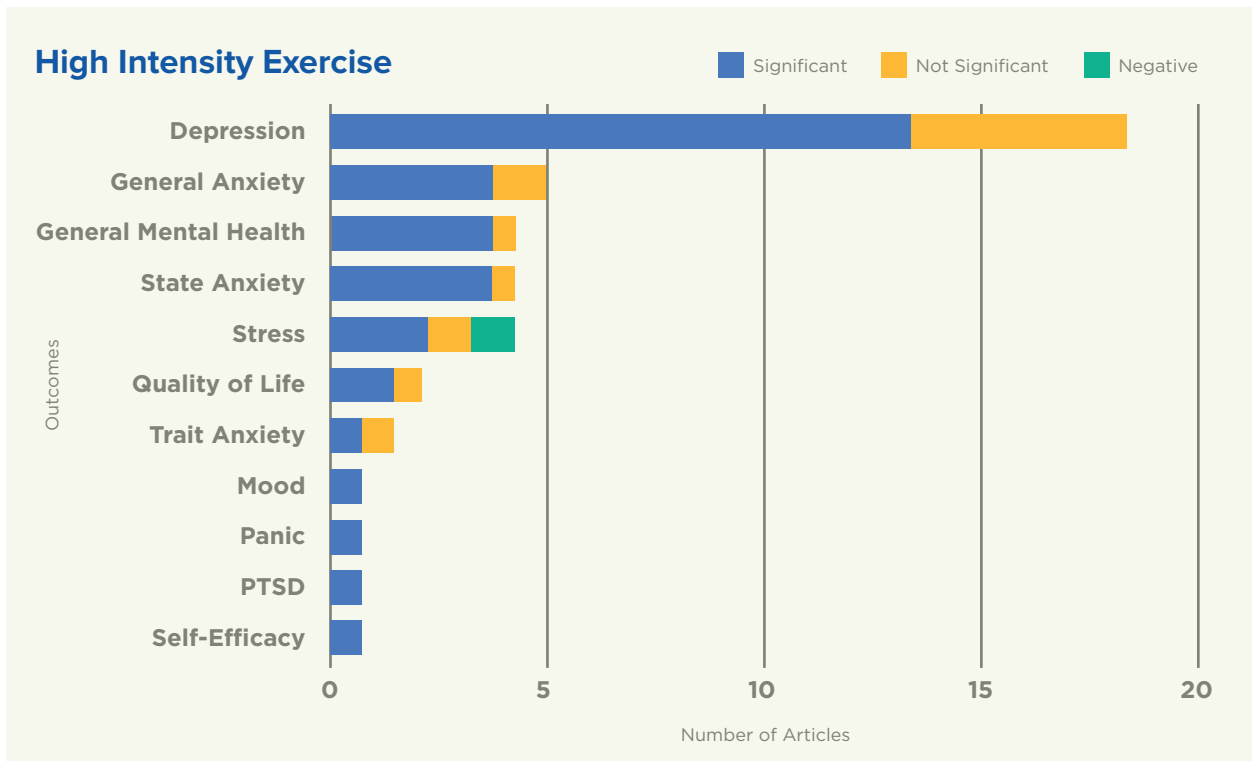
We identified 30 peer-reviewed articles examining the impact of high intensity exercise on mental health outcomes. Twenty-three of the 30 articles reported high intensity exercise being significantly associated with at least one mental health outcome. The majority of studies targeted depression (18/30), and 13 of these studies reported significant improvement in depressive symptoms following long-term or short-term high intensity activity intervention.

Evidence also supports the use of high intensity exercise for reducing anxiety, and it being superior to low-intensity exercise (Aylett et al., 2018). Acute high intensity exercise may also provide immediate same-day mental health benefits. One study (Heggelund et al., 2014) indicated for example that 36 minutes of high intensity interval training improved positive affect and well-being and reduced distress and state anxiety in patients with depression and schizophrenia.

Evidence indicates that high intensity exercise increases brain-derived neurotrophic factors (BDNF), which leading theories indicate may be responsible for exercise-induced neuroplasticity leading to anti-depressant effects. Increases in cortisol may lead to increased endocannabinoids such as anandamide (AEA), a fatty acid neurotransmitter derived from the non-oxidative metabolism of an essential omega-6 fatty acid (interestingly, this name is taken from the Sanskrit word ananda, which means “joy, bliss, delight”). These in turn are thought to encourage increased BDNF. In this way, some researchers theorize that “intensity acute exercise represents a physiological stressor able to increase peripheral levels of AEA and that BDNF might be a mechanism by which AEA influences the neuroplastic and antidepressant effects of exercise.” (Heyman et al., 2012).

Five meta-analyses and systematic reviews evaluated the influence of high intensity physical activity on anxiety, depression, general mental health, and mood outcomes. Most of these reviews (80%) reported that high intensity exercise significantly improves mental health. The sole review (Baker et al., 2016) that did not show significant benefit concluded that results were not as strong in part because mental health variables were a secondary outcome. No narrative reviews were identified on this topic.

Access High Intensity Activity and Mental Health articles included in this [review here](#).



**Figure 11:** Number of significant, not significant, and negative results reported in the High Intensity and Mental Health articles.

# LOW INTENSITY EXERCISE

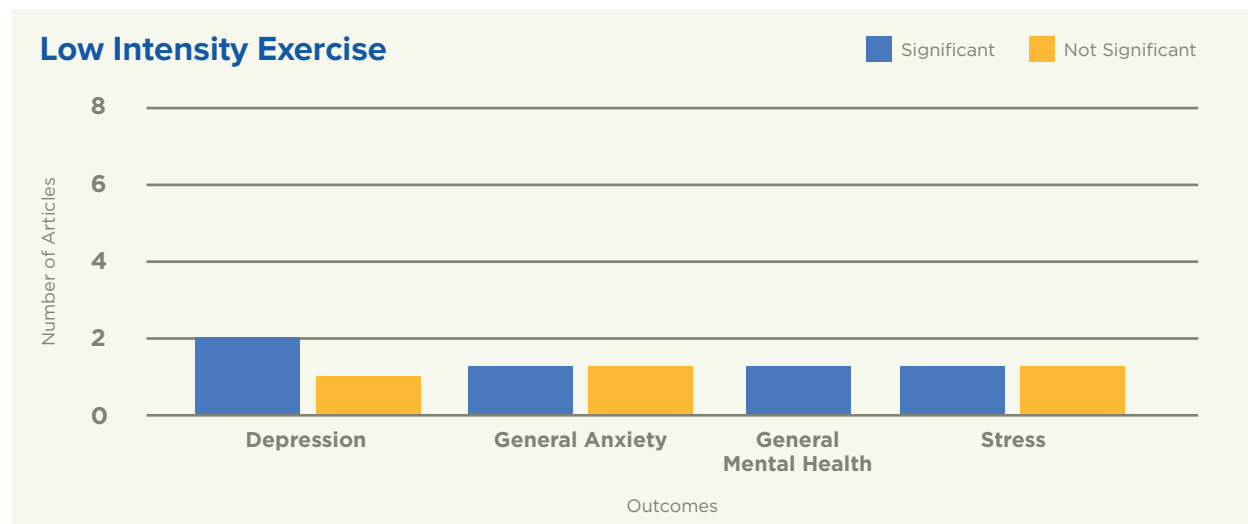
A total of 6 peer-reviewed studies that looked at the relationship between low-intensity exercise and mental health outcomes were included in this review. This section includes articles that investigate unspecified low-intensity exercise, typically as one of the conditions in a study of various levels of intensity. Specific activities which can be performed at low intensity, such as walking or cycling, are in their own dedicated sections.



Low-intensity exercise is often defined as achieving approximately 50 – 65 percent of one’s maximum heart rate for a sustained period of time. People doing low-intensity exercise (think walking along a flat surface or a leisurely bike ride) can easily talk. Another method ([Harvard School of Public Health](#)) of measuring low-, medium- and high-intensity exercise is in “metabolic equivalents” or METs. Sitting quietly burns about 1 calorie for every 2.2 pounds in body weight, so someone weighing 160 pounds would burn about 70 calories per hour. One MET is the energy it takes to sit quietly. Low-intensity exercise is defined as 1-3 METs, medium-intensity exercise is 3-6 METs, and vigorous exercise is over 6 METs.

Half of these articles focused on depression (3/6), and two of these studies showed significant improvement in depression after receiving the low-intensity intervention. This review included one meta-analysis which concluded that low-intensity exercise programs do significantly reduce mild-to-moderate anxiety symptoms in midlife and older women. No narrative reviews were identified on this topic.

Access Low Intensity Activity and Mental Health articles included in this [review here](#).



**Figure 12:** Number of significant, not significant, and negative results reported in the Light/Low-Intensity and Mental Health articles.



# MARTIAL ARTS

Martial arts ([Encyclopedia Britannica](#)) find their roots in various styles of combat training or skilled fighting sports, many of which have East Asian origin such as kung fu, judo, karate, and kendo. They can take the form of self-defense such as aikido and hapkido. While originally used for combat, most people today engage in these practices for health, self-discipline, or as a spiritual or philosophical practice. The philosophy of several martial arts are derived from Taoism and Buddhism, which emphasize mental and spiritual states of those who practice. As a result, many people today who practice these various martial arts also incorporate these philosophies and pay close attention to their internal states while moving.



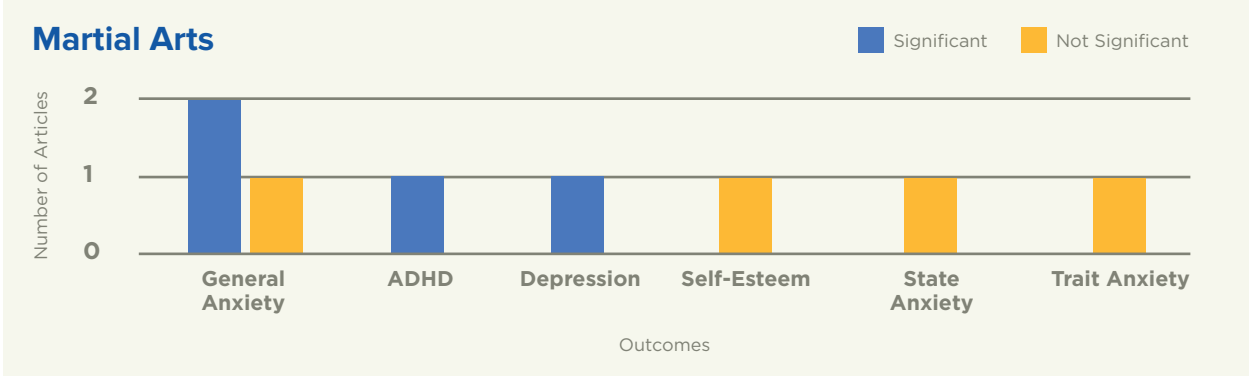
Our review identified five peer-reviewed publications that examined the impact of martial arts on at least one mental health outcome. The styles of martial arts examined in these articles include the Japanese studies of aikido and karate, a traditional Chinese form of boxing known as “twenty-four move shadow boxing,” and other styles such as krav maga, jiu-jitsu, and kickboxing, among others.

Out of the five studies, two showed no significant association of aikido or karate with outcomes of general anxiety, self-esteem, state anxiety, and trait anxiety. However, the other three articles identified positive, significant relationships between practicing martial arts and outcomes of general anxiety, depression, and ADHD symptoms. One of these articles in particular examined the role of experience and training in a martial art with performance of police officers under high and low anxiety situations ([Renden et al., 2015](#)). Though the results of this study showed that additional martial arts experience improved performance in anxiety-inducing situations overall, but did not prevent performance reductions in high vs. low anxiety situations. Another study ([Zheng et al., 2015](#)) evaluated the traditional Chinese boxing style called “twenty-four move shadow boxing,” showing significant therapeutic effects in patients with depression and anxiety. This specific style of martial art is considered a slower-tempo exercise, emphasizing consciousness, breath, calmness, and a balance between the mind and movement.

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

To learn more about the articles included in this review, please [see here](#).





**Figure 14:** Number of significant, not significant, and negative results reported in the Martial Arts and Mental Health articles.

## MODERATE INTENSITY EXERCISE

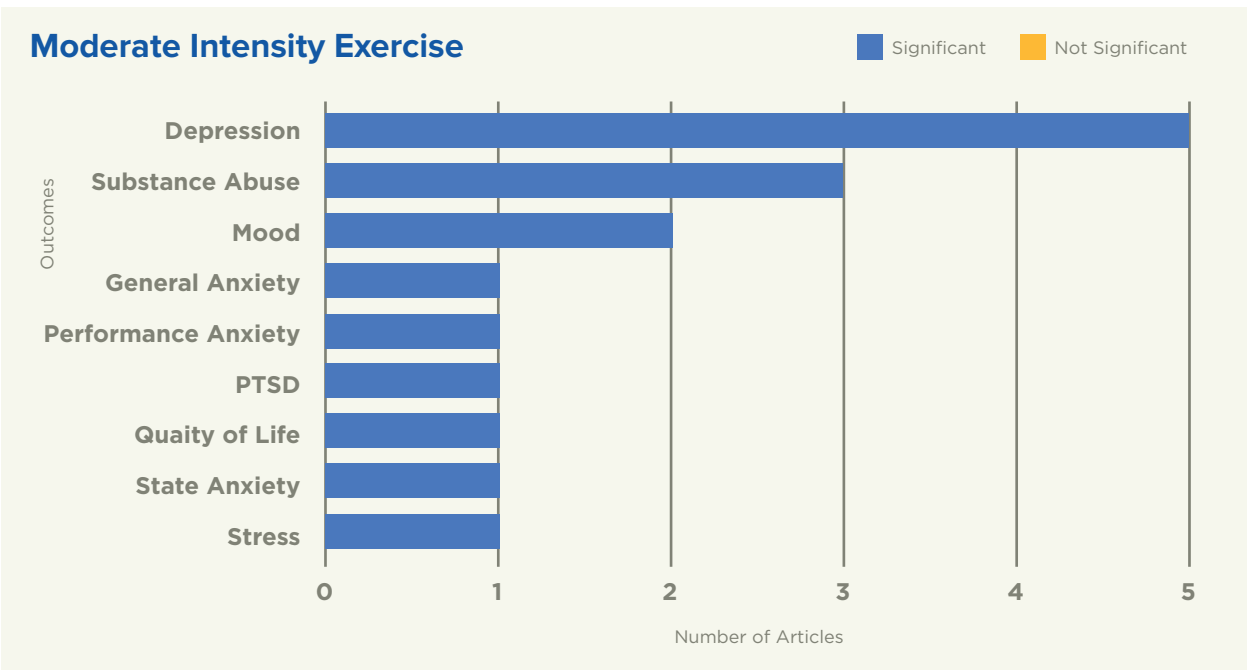
This review identified 14 peer-reviewed publications that analyzed the impact of medium or moderate-intensity physical activity on mental health outcomes. As mentioned in the previous section, researchers define moderate-intensity exercise as physical activity that uses 3 – 6 times the energy it takes to sit quietly, or achieving ~60-75% of one's maximum heart rate. Examples include walking briskly, heavy cleaning, doubles tennis, or exercise associated with a small to moderate increase in rate of breathing.



All of the articles reported significantly positive relationships between moderate-intensity exercise and mental health, with the strongest effects on depression (5/14), followed by substance abuse (3/3) and mood (2/2). For example, one study showed that a session of 30 minutes of moderate exercise improves mood and activates the endocannabinoid system (a molecular system responsible for regulating and balancing many processes in the body, including immune response, communication between cells, appetite and metabolism, memory, and more) in both healthy adults and people with post-traumatic stress disorder (Crombie et al., 2018).

This review additionally included two meta-analyses and systematic reviews, both of which reported significant improvement outcomes for symptoms of depression. An important finding in one of these is that moderate-intensity exercise was essentially equivalent to vigorous-intensity exercise in reducing depression, which could make it easier for people with mental health struggles to comply with exercise regimen recommendations. No narrative reviews were identified on this topic.

Access the Moderate-Intensity Activity and Mental Health articles included in this section [here](#).



**Figure 13:** Number of significant, not significant, and negative results reported in the General Physical Activity and Mental Health articles.

# GENERAL PHYSICAL ACTIVITY



The largest category in this project, 423 articles explored the association of “general physical activity,” with mental health. This category includes overall day-to-day body movement as well as types of physical exercise not otherwise specified. These include things like activity at work (lifting, walking, standing), travel to and from places (walking, cycling, etc), housework, and recreational activities. Physical activity is often measured in contrast to sedentary behavior, defined as “sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, train, reading, playing cards or watching television, but do not include time spent sleeping.” ([World Health Organization, 2017](#)).

Most of these articles (370/423) reported at least one significant association of general physical activity with improved mental health outcomes. The majority of these studies focused on depression, general anxiety, quality of life, and general mental health, followed by stress, general well-being, and mood. Only six studies reported that general physical activity had a negative effect or were associated with increased symptoms of general anxiety, depression, mood, bipolar disorder, substance abuse, or stress.

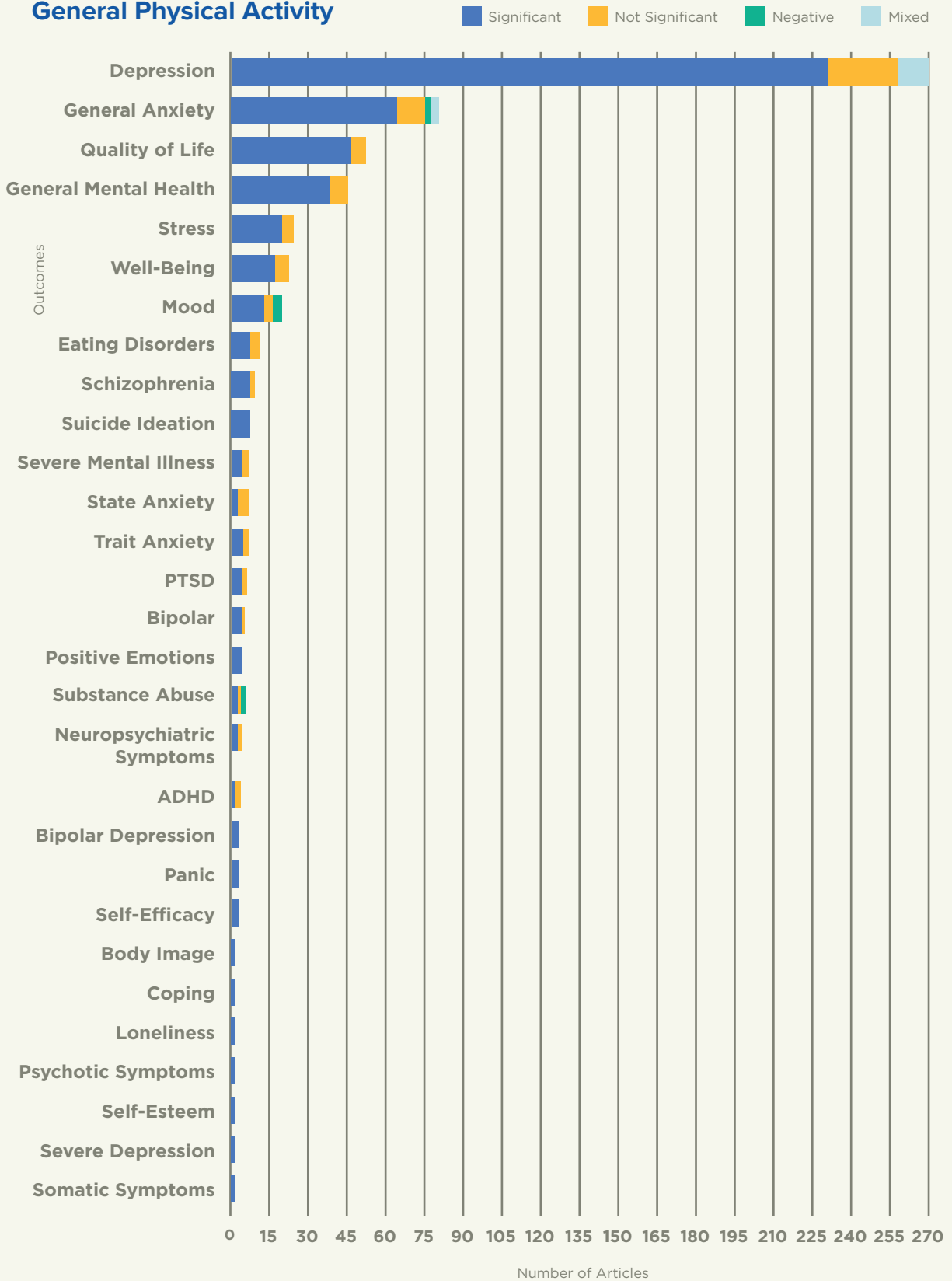
Overall, physical activity in general was associated with, or improved through interventions, a variety of mental health concerns. This literature is important in part because exercise and physical activity for improving mental health may not need to be set aside as an additional, separate, or new activity, but can be integrated into everyday life – for example, taking the stairs rather than the elevator, walking or biking to work or school rather than driving or taking the bus, or using walking workstations.

We identified 86 meta-analyses and systematic reviews on this topic, 78 of which demonstrated at least one positive relationship between general physical activity and mental health outcomes. Eight concluded that results were mixed, and another eight summarized null/non-significant results.

A total of 71 narrative reviews were identified, which primarily examined the potential association of general physical activity on depression and general mental health, as well as severe mental illness, general anxiety, schizophrenia symptoms, PTSD symptoms, mood, and eating disorders.

To learn more about the articles included in this section, please [see here](#).

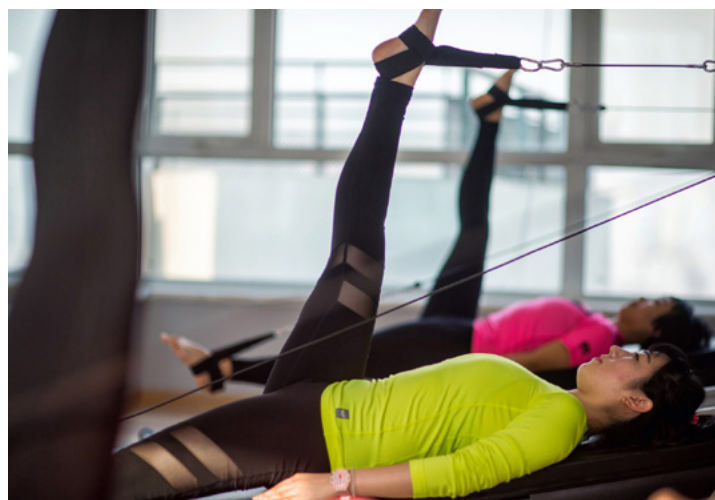
## General Physical Activity



**Figure 15:** Number of significant, not significant, and negative results reported in the General Physical Activity and Mental Health articles.

# PILATES

Pilates, a form of exercise developed in the early 20th century by Joseph Pilates, has grown in popularity and practice in recent decades. It is a form of low-impact exercise that aims to strengthen muscles while improving postural alignment and flexibility. It encourages people to utilize their own body weight for strength training and emphasizes core strength and posture (Fleming et al., 2019). Pilates training occurs in individual or group classes, either on a mat that is slightly thicker than a yoga mat, or using a machine called a reformer, which is a sliding platform complete with stationary foot bar, springs, and pulleys that provide resistance. Pilates can also be learned and practiced at home or in a studio without supervision.



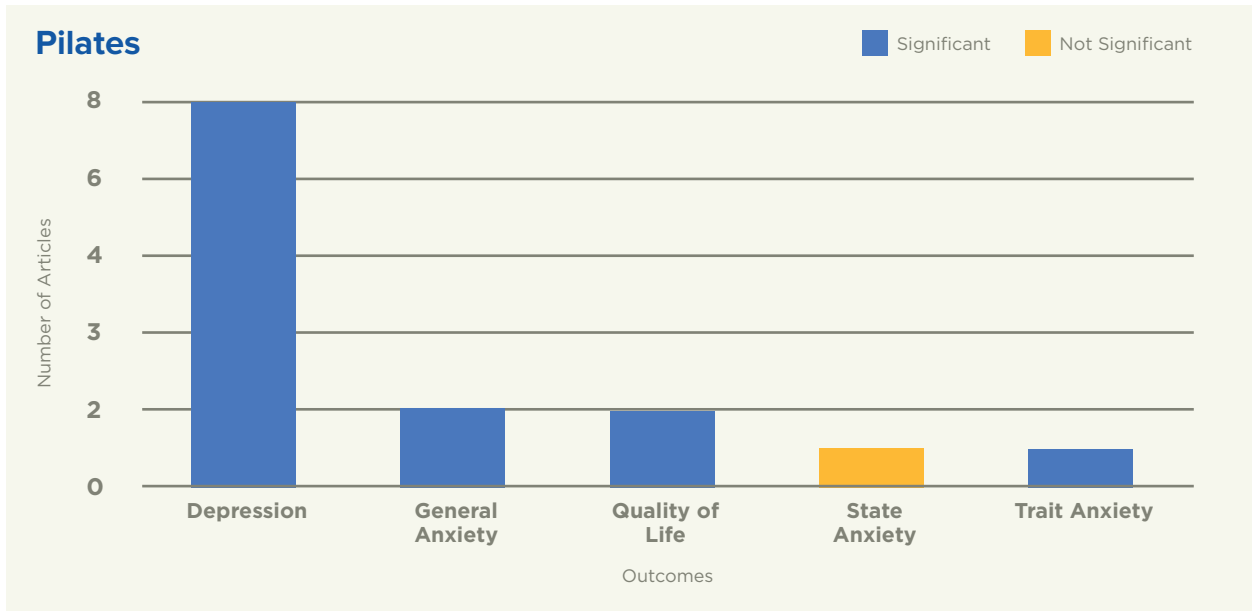
As a result, benefits from practicing Pilates includes demonstrated improvements in core stability, balance, mobility, and strength. In addition, mat-based Pilates is a feasible form of exercise that can be home-based, without requiring equipment or the use of an outside gym. Intensity of exercises can be reinforced by integrating equipment such as chairs, dumbbells, pilates reformers, medicine balls, and resistance bands (Vancini et al., 2017).

We identified 9 peer-reviewed publications exploring the impact of pilates on at least one mental health outcome. Across these studies, pilates interventions typically took place in one to three 60-minute sessions per week for a duration of between eight to twelve weeks. Taken together, results indicate that at least one 60-minute pilates session per week over the course of several weeks can lead to improved mental health outcomes.

Of the eight studies investigating pilates and depression, all reported positive, significant improvements in depression symptoms associated with practicing pilates, in populations including patients with mood disorders, post-menopausal Spanish women, women with multiple sclerosis, elderly women, and healthy university students. Five articles reported positive, significant results when examining associations between practicing Pilates and general anxiety, quality of life, and trait anxiety. One study (Vancini et al., 2017) reported no effect of Pilates on state anxiety, specifically in overweight and obese individuals, but improvements in depression, general anxiety, and overall quality of life.

One meta-analysis investigated the effects of pilates on mental health outcomes across 8 studies (Fleming & Herring, 2018). This analysis estimated the population effect size and found that practicing pilates was associated with large reductions in symptoms of depression and anxiety, reduced fatigue, and increased energy, though studies were typically small and of variable quality. No narrative reviews were identified on this topic.

To learn more about the articles in this section, please [see here](#).



**Figure 16:** Number of significant, not significant, and negative results reported in the Pilates and Mental Health articles.



# RUNNING & JOGGING

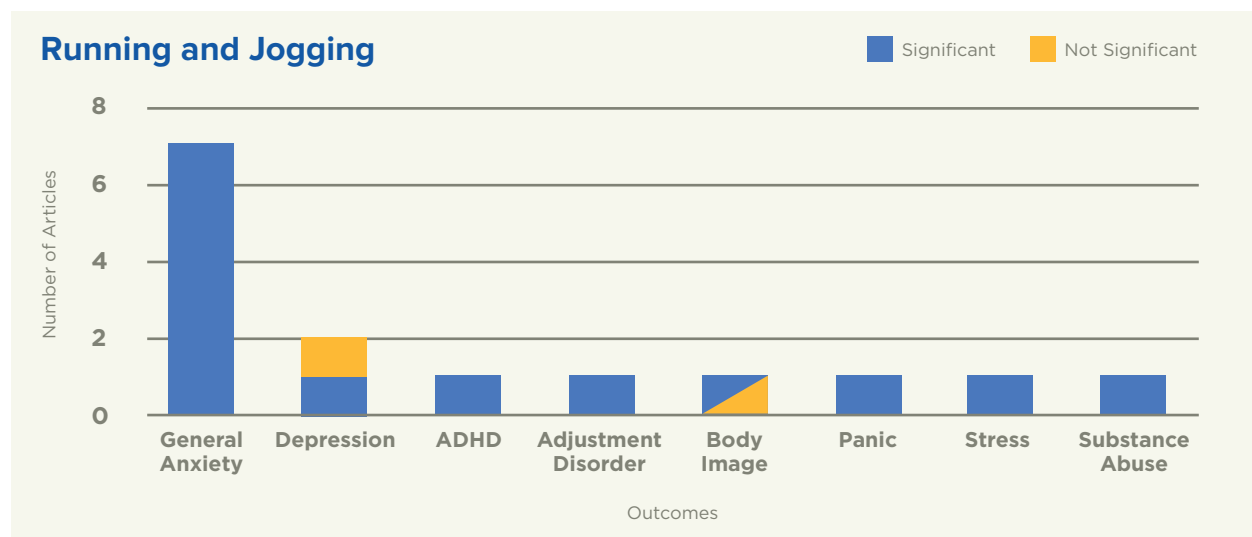


Running and jogging are both fundamental forms of human movement, and are popular ways to engage in moderate to high intensity aerobic exercise and sports (Folland et al., 2017). While running and jogging have preventive and therapeutic health benefits, primarily attributed to improved cardiovascular health and weight maintenance, there is evidence that running and jogging show positive effects on mental health as well (Koplan et al., 1982).

A total of 12 peer-reviewed studies examined the relationship between running or jogging and mental health outcomes. The majority (11/12) reported positive effects of running or jogging on at least one mental health outcome. The most commonly studied outcome was general anxiety: 5 out of 5 articles on this outcome reported significant improvement following a running or jogging intervention. One article (Anderson et al., 2016) reported mixed results of running on body image, reporting improved body image in females with body image, but not in males. Although studies are few, it appeared that running and jogging hold substantial promise for reducing symptoms of ADHD, adjustment disorder, general anxiety, body image, depression, panic disorder, stress, and substance abuse disorder.

This review did not identify any meta-analyses or systematic reviews, however one narrative review (Markotić et al., 2020) concluded that running can be a therapeutic tool for several psychological conditions. The optimal frequency, duration and intensity of running remains unknown.

Access Running/Jogging and Mental Health articles included in this section [here](#).



**Figure 17:** Number of significant, not significant, and negative results reported in the Running and Jogging and Mental Health articles.

# SPORTS

Sports are defined in this report as organized games with rules that require attention to motor actions and strategic, goal-oriented movements, usually involving moderate to vigorous physical activity. Participation in sports at various stages of the life cycle can have numerous positive effects on not only physical health, but also psychosocial, emotional, and mental health.



Examples of common sports around the world are tennis, football, basketball, track and field, soccer, baseball, cricket, and dozens more. Many sports, though not all, include elements of participation in a team, competition with others, and regular, consistent training practices involving physical conditioning and activity (Pot & Keizer, 2016).

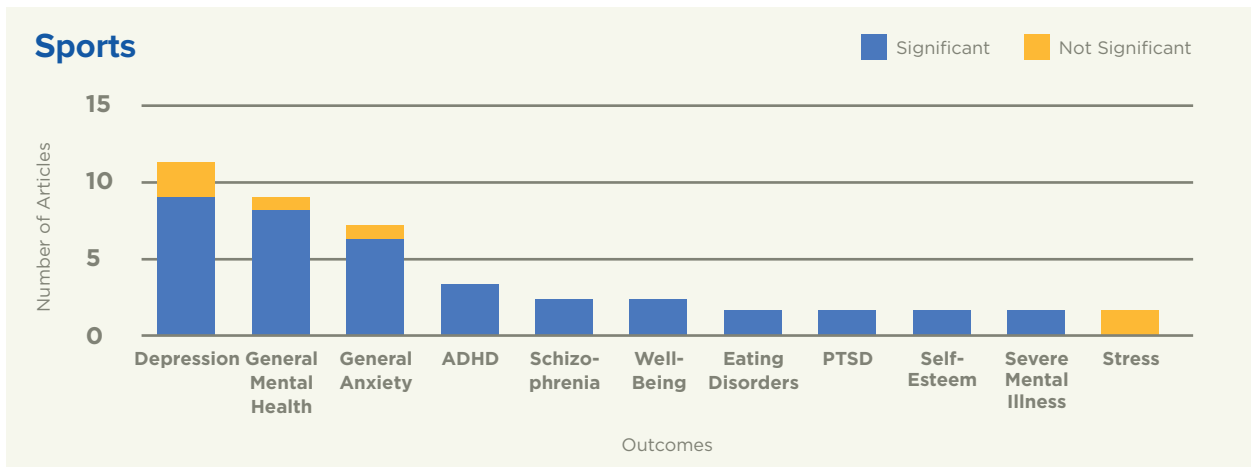
This review revealed 28 peer-reviewed publications examining the impact of sports on various mental health outcomes. Twenty-five of the 28 articles reported at least one significant mental health outcome. The most studied outcome was depression (11/28), and 9 of these 11 articles reported that sports significantly improved symptoms of depression.

For example, one article (Babiss et al., 2009) examining the effect of sports participation on depression and suicide ideation in adolescents suggested that relationship is potentially mediated by increasing endogenous endorphin levels, boosting self esteem, and increasing social support. Several other studies including Ho et al. 2017 and McMahon et al. 2017 point to the mediating effects of increased confidence, self-esteem, self-efficacy, and ways to cope with stressors as mechanisms for the relationship between sports and mental well-being in adolescents.

Although participation in sports has the potential to contribute to a multitude of mental health problems such as eating disorders, depression, and anxiety, some results from the examined articles indicated that participation in sports can also have the reverse effect, improving mental health concerns and adverse symptoms. Negative mental health outcomes of participation in sports, such as excessive training, injuries, bullying, or abusive coaching, should be a topic of future study.

Three narrative reviews that discussed the impact of sports programs on eating disorders and general mental health were included in this review. One notable narrative review (Chang et al., 2020) considered the competitive athlete, and how support staff (team physicians, athletic trainers, mental health care providers, etc.) can play a key role in the detection and treatment of psychological issues. No meta-analyses or systematic reviews were identified.

Access Sports and Mental Health articles included in this [review here](#).



**Figure 18:** Number of significant, not significant, and negative results reported in the Sports and Mental Health articles.

# STRENGTH, WEIGHT & RESISTANCE TRAINING



Strength, weight, and resistance training all describe exercises that are targeted towards building and increasing muscle strength and improving muscular fitness. This type

of exercise enforces muscles to contract and move against some type of external “resistance”, which may take the form weights (such as dumbbells), body weight (such as push-ups or pull-ups), or exercise tubing and elastic bands (Liu & Latham, 2009). Strength training is shown to offer benefits by increasing muscle mass, improving overall body strength and stability, and reducing loss of function and movement limitations later in life (Kekalainen et al., 2018). For older populations especially, who tend to lose muscle strength as they age and weaken progressively, resistance training is a recommended type of exercise, conducted two to three times a week at moderate intensity (Liu & Latham, 2009).

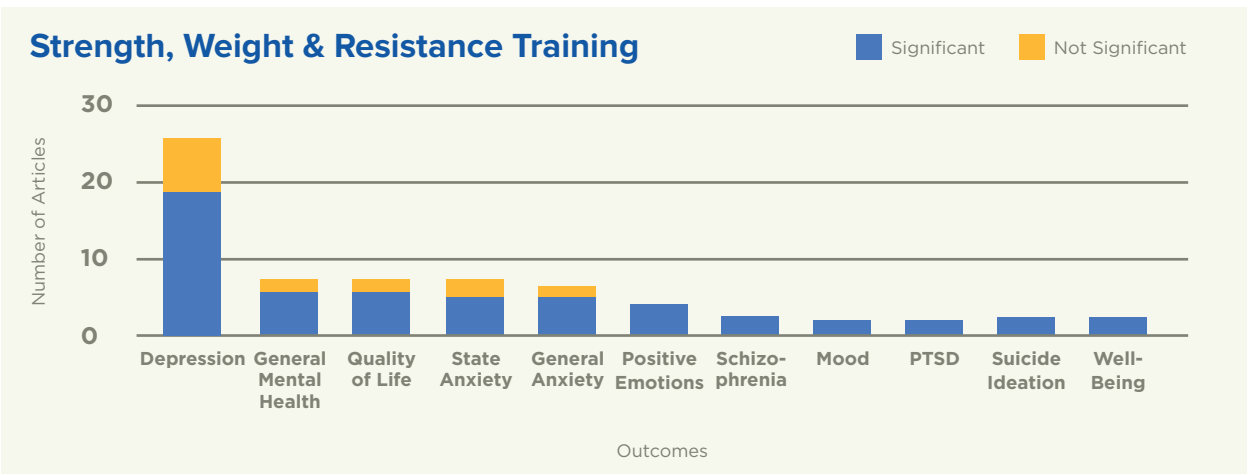
This review identified a total of 45 studies that examined the influence of strength, weight and resistance training on mental health outcomes. Of these, 38 reported at least one significant mental health outcome. A majority of these articles reviewed the effects of strength, weight or resistance training on depression (26/45), with the next most studied outcomes being general mental health (7/45), and quality of life (7/45). Many articles showing a positive relationship between strength or resistance training and depression focused on older people.

Some evidence indicates that strength/resistance training performed at high-intensity is most beneficial for improving depression outcomes. For example, one study (Singh et al., 2005) randomized people over 60 with either minor or major depression to high-intensity, low-intensity, or general practitioner (GP) care. A 50% or over reduction in depression symptoms was observed in 61% of the high-intensity, 29% of the low-intensity, and 21% of the GP care groups. Increases in strength and social support were partially responsible for the positive effects on depression.

There is some evidence that progressively increasing strength/resistance training over time is ideal for mental health applications, since acute strength/resistance training can increase anxiety (Bibeau et al., 2010), and low-intensity strength/resistance training can increase positive emotion without the accompanying increase in anxiety. This may in turn increase compliance/adherence.

The review identified two meta-analyses and one systematic review that monitored the effects of strength, weight and resistance training on different mental health outcomes. These reviews indicated significant and robust benefits of strength/resistance training on depression and general anxiety, and some promise for schizophrenia symptoms (2 studies). No narrative reviews were identified.

Access Strength, Weight and Resistance Training and Mental Health articles included in this [review here](#).



**Figure 19:** Number of significant, not significant, and negative results reported in the Strength, Weight, and Resistance Training and Mental Health articles.

## TAI CHI & QIGONG

Tai Chi ([Liu et al., 2020](#)) and Qigong ([Ho et al., 2012](#)) are mind-body exercises originating in China and practiced throughout the world. Both involve coordinated slow-flowing movement and deep rhythmic breathing while cultivating a calm meditative state of mind. The



movements are thought to facilitate the flow of energy (qi) and balance mind, body, and spirit. Tai Chi is typically more complex, with a series of “forms” or specific postures and movements, and is considered a martial art. Qigong often repeats simple movements, is more adaptive, and is utilized as a wellness practice. The elements of mental concentration, relaxation, and physical balance make Tai Chi and Qigong potential therapeutic practices for mental health benefit.

In this review we identified 49 peer-reviewed publications examining the relationship between practicing Tai Chi or Qigong on mental health outcomes. Of these articles, 48 showed a significant relationship between the practice of tai chi or qigong and at least one mental health outcome. Only one article, which evaluated depression and tai chi or qigong, displayed non-significant results. None of the selected articles indicated a negative relationship between practicing tai chi or qigong with mental health outcomes. A majority of the articles we reviewed assessed depression as the mental health outcome, with general anxiety as a close second. Overwhelmingly, 27 out of the 28 articles that evaluated depression reported a significant positive relationship between practicing Tai Chi or Qigong and improved outcomes of depression. One article ([Liu et al., 2020](#)) shows that practicing Tai Chi can serve a protective function in patients with coronary heart disease (CHD) by improving symptoms of anxiety and depression. A second article ([Tsai et al., 2003](#)) showed that treatment with tai chi decreased trait and state anxiety in patients with CHD. Tai chi was also associated with lower blood pressure and reduced serum low-density lipoproteins (LDL) (so-called “bad cholesterol”), while increasing serum high-density lipoprotein (HDL) levels (“good” cholesterol).

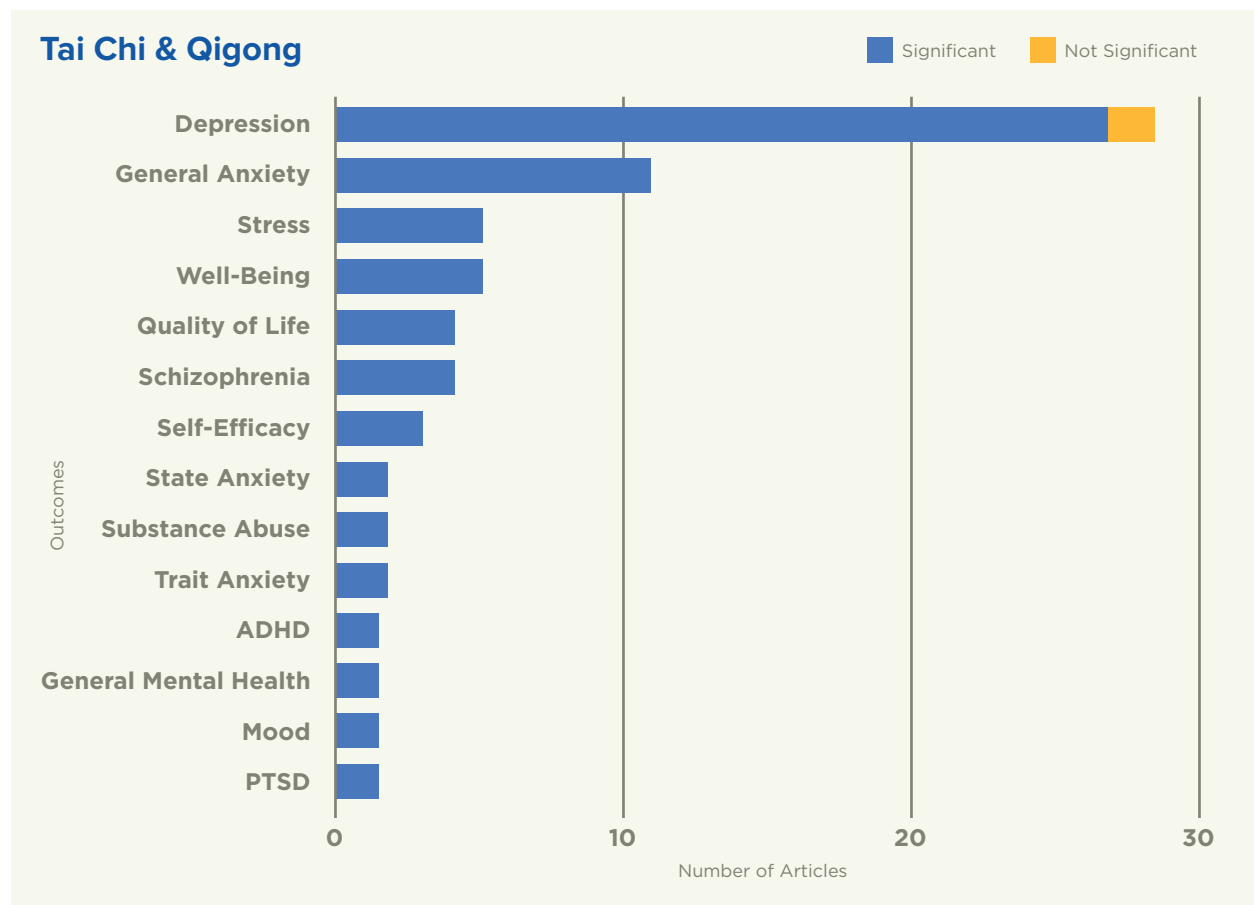
In addition, all 11 articles that assessed general anxiety outcomes showed a significant positive relationship between practicing tai chi or qigong and reduced anxiety. One of these articles showed that Qigong increased telomerase activity ([Ho et al., 2012](#)). Telomeres are sequences of DNA at the ends of our chromosomes that serve a protective effect for our genes against oxidative stress throughout the cell cycle. Telomerase is an enzyme that can improve the longevity of telomeres, thus protecting our chromosomes and promoting cell growth. The study found increased telomerase activity in those engaging in a 4-month Qigong intervention program, as well as improved mental health.

In other articles, Tai Chi and Qigong were significantly associated with improved stress, quality of life, schizophrenia symptoms, ADHD symptoms, and substance abuse.

Our review also identified six meta-analyses and systematic reviews evaluating the impact of Tai Chi or Qigong on at least one mental health outcome, all of which found significant positive associations between practicing Tai Chi or Qigong and improvement in mental health outcomes. Of these six articles, five reported a significant positive impact of practicing Tai Chi or Qigong on general anxiety. Stress, depression, quality of life, and self-efficacy were also evaluated in these articles, all of which showed significant, positive relationships.

This review identified two narrative reviews that evaluated the impact of practicing Tai Chi or Qigong on outcomes of stress and general well-being.

To learn more about the articles identified in this section, please [see here](#).



**Figure 20:** Number of significant, not significant, and negative results reported in the Tai Chi and Qigong and Mental Health articles.



# THERAPEUTIC ACTIVITIES



When we refer to therapeutic activity or exercise, this includes repeated and regular movements designed to be restorative to musculoskeletal health. These exercises are rehabilitative in nature and typically implemented in physical and occupational therapy. Repeated movements are usually

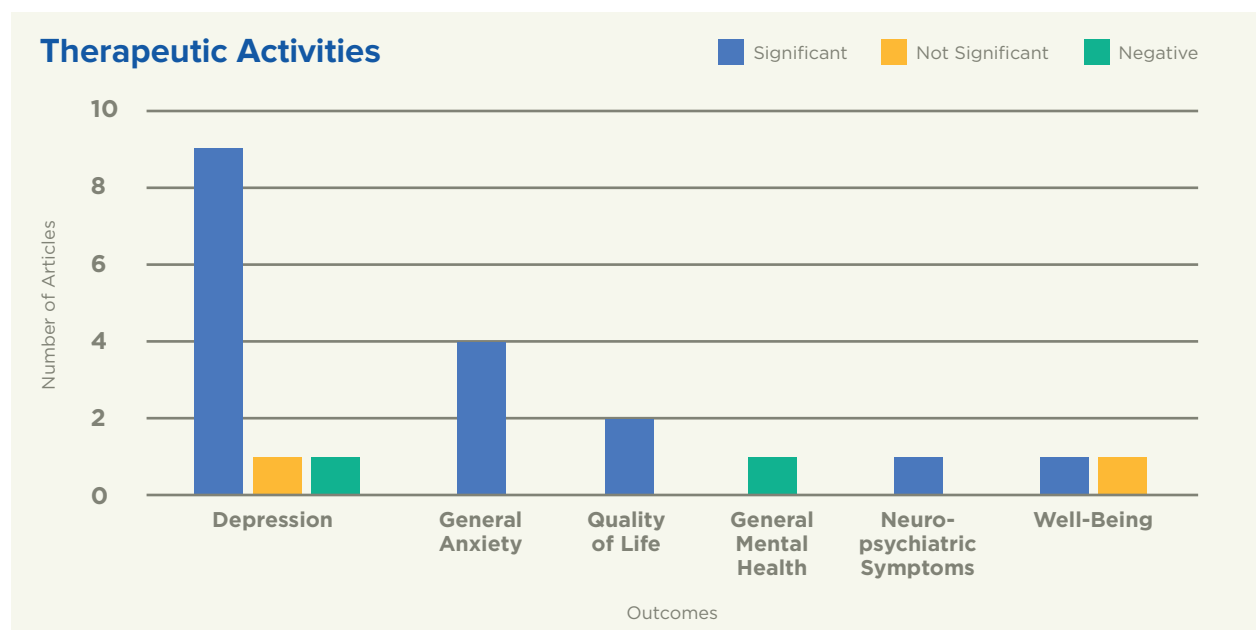
focused at musculoskeletal joints or specific areas of injury that need extra care or strengthening (Bielecki & Tadi, 2020). Therapeutic exercises can also involve whole-body exercises that focus on improving balance, range of motion, endurance, and strength in individuals.

This review identified 14 studies that examined therapeutic activities, primarily for older adults and individuals with health conditions, such as hemodialysis patients or nursing home residents with dementia. The category of therapeutic activity included exercises designed to boost activities of daily life (ADL), exercise specifically for specific patient populations, or protocols to increase the accessibility of exercise like the development of a floor-seated exercise program for the elderly. Our review focused on mental health outcomes only.

The majority of articles showed significant benefits for depression, with the only negative finding being an association between being in an exercise program for scoliosis and depressive symptoms among adolescents (Płaszewski et al., 2014).

No meta-analyses, systematic reviews, or narrative reviews were identified on this topic.

Access Therapeutic Activity and Mental Health articles included in this [review here](#).



**Figure 21:** Number of significant, not significant, and negative results reported in the Therapeutic Activities and Mental Health articles.

# WALKING

Though walking is not always considered a form of formal or vigorous exercise, it is a practical and cost-effective form of physical activity, especially for people who are limited in mobility due to age, physical condition, or external restrictions.

Due to its feasibility for individuals, a walking regiment promotes consistent physical activity engagement and improved health benefits. Several health benefits are linked to walking, including positive effects on blood pressure, cardiovascular health, weight loss, and mental health outcomes ([Hanson et al., 2015](#)).



This review identified 57 peer-reviewed articles that investigated the relationship between walking and mental health outcomes. Fifty-three of the 57 articles showed a significant positive relationship between walking and at least one mental health outcome, whereas 6 of the articles reported non-significant effects of walking in at least one mental health outcome. Namely, a few of the null-result reports evaluated the effect of walking and depression in perinatal women. We do see overwhelmingly positive, significant results out of the studies that investigated walking in older, aging populations. A longitudinal study of 8,370 women ([Heesch et al., 2011](#)) showed an inverse dose-response relationship between walking and other physical activity and depression and anxiety in older women. In other words, higher levels of walking were associated with fewer depressive and anxiety symptoms. Since the study was correlational, it is not possible to determine whether one causes the other, or in which direction.

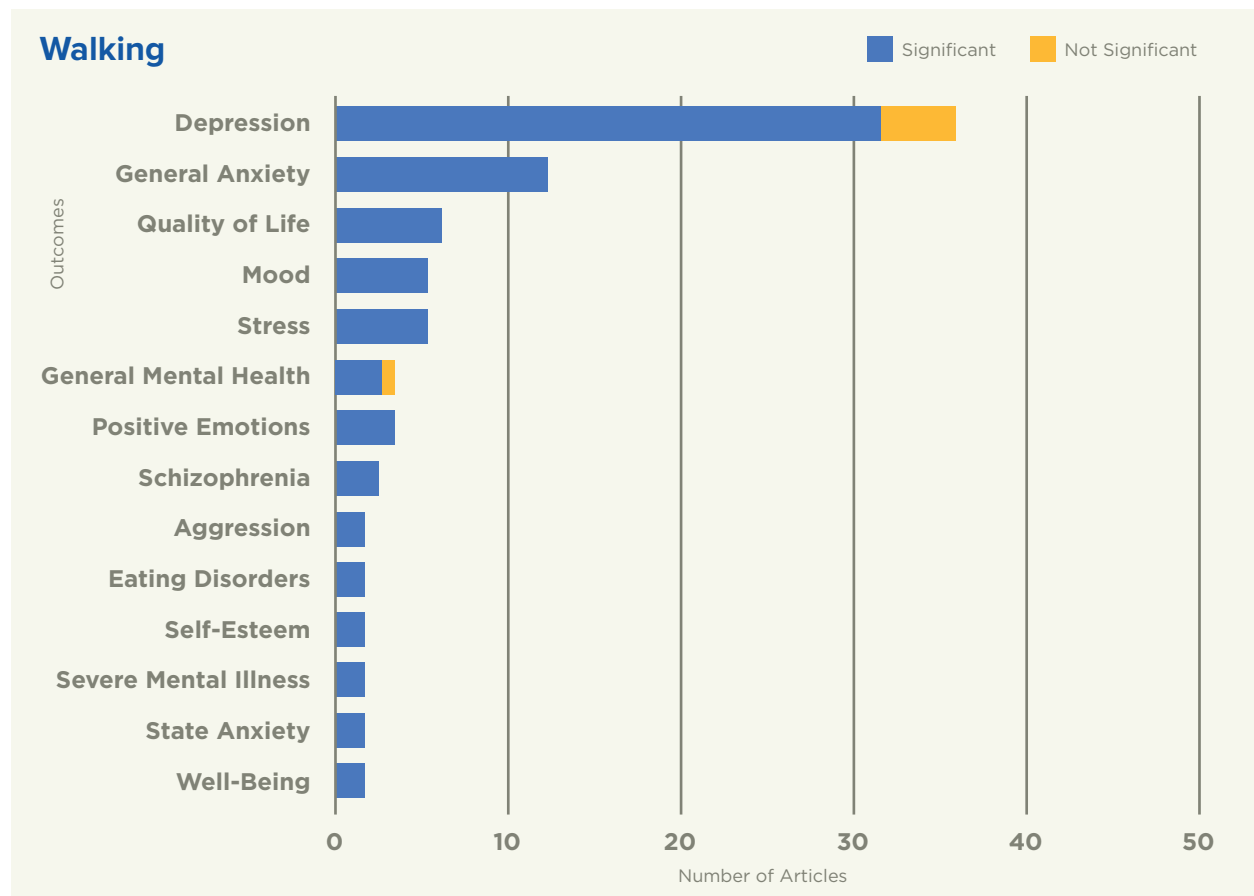
Depression was the most evaluated mental health outcome, with 31 out of 36 of these studies showing significant positive associations between walking and improved depressive outcomes. Additionally, general anxiety, quality of life, mood, and stress were also evaluated. All of the articles evaluating the association of walking and improving these mental health outcomes showed significant, positive results. Interestingly, only one article out of four which assessed general mental health as an outcome showed non-significant results, while the remaining showed a positive significant relationship with walking. Though several articles mention that it is difficult to elucidate exact mechanisms to this positive relationship, one article ([Carter et al., 2018](#)) highlights the potential aspect of ease of daily living. In this article, interventions to reduce walking difficulty in breast cancer survivors showed greater engagement in physical activity and significantly less psychosocial distress, leading to better mental health outcomes. This suggests the therapeutic effectiveness that walking can provide, in conjunction with other interventions, to improve mental well-being.

Our review also identified three meta-analyses and systematic reviews, two of which showed significant positive relationships between walking and at least one mental health outcome. One article showed that walking had a positive impact on outcomes of general anxiety, depression,

and stress. A second report showed that walking had a significant positive relationship with improved mood. The third report, however, assessed the relationship between walking with depression and quality of life and found null results.

Four narrative reviews were evaluated in this report, two of which discussed the relationship between walking and depression as the mental health outcome. The remaining two narrative reviews examined the impact of walking on outcomes of general mental health and severe mental illness.

To learn more about the articles identified in this review, please [see here](#).



**Figure 22:** Number of significant, not significant, and negative results reported in the Walking and Mental Health articles.

# YOGA

The practice of yoga is a several thousand years old tradition originating in ancient India. It is popular throughout the world as a form of exercise, moving meditation, and complementary therapy for a number of conditions. The word “yoga” has similar roots to the word “yoke” – meaning to “tie together”



mind, body and spirit. Hatha Yoga is the physical branch of yoga most people are familiar with, and consists of assuming various postures called “asanas,” combined with breathing and body awareness, typically in a sequence. In addition to its spiritual aspects, yoga is designed to promote strength, flexibility, self-control, relaxation, and endurance.

Yoga is a widely recognized and studied component of several therapeutic interventions for mental health outcomes (Woodyard, 2011). There are multiple forms of yoga, several of which have been adapted in modern times, such as Iyengar yoga, which focuses on disciplined postures, Bikram or “hot” yoga performed in heated studios, restorative yoga which is typically more slow and gentle, strenuous Ashtanga or “power” yoga, and more. Comprehensive interventions that include yoga have been developed, such as Sudarshan Kriya Yoga (SKY) (Doria et al., 2015), which is a yoga practice that focuses on breathing exercises, body posture, meditation, and cognitive-behavioral interventions.

This review identified 189 articles and reports investigating the relationship between yoga and various mental health outcomes. Of these articles, 165 reported a significant relationship between practicing yoga and at least one mental health outcome. Twenty-four articles (15%) reported non-significant results, with one of these studies (Ikai et al., 2014) reporting a negative impact on stress.

A majority of the included reports studied depression as the mental health outcome. Within these 97 articles, 85 showed significant positive associations between practicing yoga and improving depression outcomes. Notably, one of the articles (Uebelacker et al., 2017) which evaluated depression as the mental health outcome showed mixed results. From this study, results showed positive significant impacts of yoga on symptoms of depression immediately after the trial and at follow-up, however did not show significant results at 10-weeks post-intervention.

One proposed mechanism to explain how yoga improves mood is the GABA hypothesis. Gamma aminobutyric acid (GABA) is an amino acid neurotransmitter thought to be a contributing factor in mood and anxiety disorders. Lower GABA levels have been associated with mood disorders such as depression. One study (Streeter et al., 2020) was able to provide preliminary support for this hypothesis, where a yoga intervention was shown to increase GABA system activity, improve mood, and decrease depressive symptoms. Another hypothesized mechanism highlighted in

some research ([Naveen et al., 2016](#)) is the association between depression, low levels of brain-derived neurotrophic factor (BDNF), and elevated levels of cortisol. This study showed in patients who practiced yoga a significant correlation between changes in BDNF and cortisol levels, and improvement of depressive symptoms.

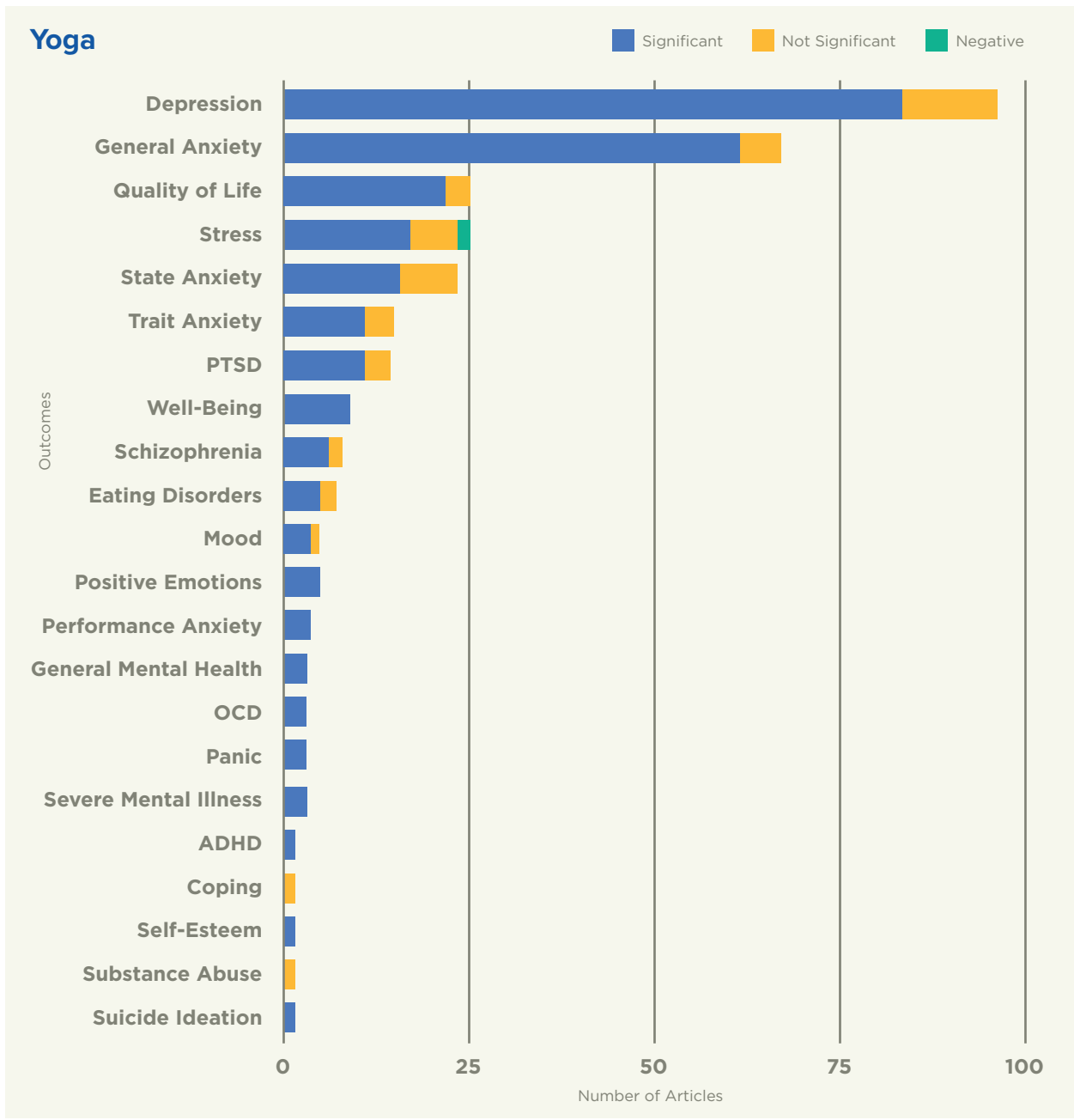
The next most studied mental health outcome was general anxiety. Out of the 68 articles that investigated yoga and general anxiety, 62 reported that yoga was significantly associated with improving anxiety outcomes. In addition, 23 articles evaluated state anxiety and 15 articles examined trait anxiety as outcomes. A majority of these articles saw significant positive associations between practicing yoga and improved state and trait anxiety.

Other notable outcomes include quality of life, stress, and PTSD symptoms. Overall, a majority of articles reported a positive significant relationship between practicing yoga and beneficial outcomes.

This review identified 36 meta-analyses and systematic reviews which evaluated the impact of yoga on various mental health outcomes. Out of these reviews, 25 reported significant positive results in at least one mental health outcome from practicing yoga. A majority of these reviews examined general anxiety and depression as the mental health outcomes. Notably, six of the eight reviews that evaluated schizophrenia symptoms as the outcome showed non-significant results associated with practicing yoga.

Additionally, 22 narrative reviews were identified in our report. A majority evaluated depression and general anxiety as the outcome, while the remaining articles discussed general mental health, PTSD, schizophrenia, eating disorders, and substance abuse outcomes.

To learn more about the articles identified in this review, please [see here](#).



**Figure 23:** Number of significant, not significant, and negative results reported in the Yoga and Mental Health articles.





# MOVE YOUR MENTAL HEALTH

# CONCLUSIONS & RECOMMENDATIONS

Is there currently enough evidence to support prescribing exercise to improve symptoms of mental illness, and recommending exercise to promote mental health and wellness?

## Depression

For symptoms of depression, the answer is unequivocally yes. In fact, the existing body of literature indicates that exercise should be integrated into the treatment of people with depressive symptoms or major depression. The data are strong enough that people who present with depression should not only be evaluated for medication and psychotherapy, but also physical therapy and supervised group exercise, the cost of which should be covered by insurance.

While consensus-based standardized protocols are needed, evidence suggests the exercise should:

- Include a combination of aerobic and resistance training;
- Occur 4-5 times per week;
- Be gradually increased over time to reach moderate-to-high levels of intensity for 30-45 minutes per session;

This project was a scoping review, rather than a meta-analysis or systematic review. Therefore we did not select only high-quality studies, nor did we evaluate studies for strength of evidence. The goal was to identify as many published studies as possible on the relationship between physical activity/exercise and mental health outcomes. Our conclusions and recommendations are based on the number of articles, proportion of articles reporting significant results, number and proportion of randomized controlled trials, and our reading of the systematic reviews, meta-analyses, and meta-reviews in each exercise/physical activity and mental health outcome category. Therefore, these conclusions and recommendations can best be described as themes across the scientific literature that are supported by evidence.



- Be routinely integrated into inpatient and outpatient treatment;
- Be supervised individually or in groups for a period of at least 8-12 weeks to overcome symptomatic barriers to exercise (such as lethargy or anhedonia or inability to derive pleasure from activities);
- Be supervised by a fitness professional who has ideally received training in mental health issues as they relate to exercise;
- Take into account enjoyment of the type of exercise, as well as cultural and community relevance of the type of exercise, to increase adherence. In other words, it is important to find forms of exercise that people enjoy and will actually integrate into their lives in the long term. It is also advisable to find forms of exercise that are familiar, fit with the person's culture, and accessible in the patient's culture or community.

### **Anxiety**

The evidence we reviewed was strong but slightly less robust for general, trait and state anxiety, leading us to the conclusion that cardio-aerobic and resistance exercise should be strongly considered for integration into treatment of symptoms of anxiety. Exercise in treatment of anxiety should, in addition to the bullet points described above for depression:

- Integrate yoga, Tai Chi, Qi Gong or other forms of restorative, mindful, or meditative exercises at least 1-2 times per week;
- Acknowledge that while for some people, exercise can reduce anxiety immediately following a session, for other people exercise can increase anxiety immediately after a session, perhaps due to activation of the hypothalamic pituitary axis and increased cortisol. In addition, anxiety can sometimes be increased by the expectation to adhere to an exercise program over time.

### **Bipolar Disorder and Schizophrenia**

For bipolar (“manic-depressive”) disorder and schizophrenia and other disorders with psychotic features, evidence was less robust, with fewer peer-reviewed publications and more null or ambiguous results. For these serious mental illnesses (SMI), exercise and physical activity was more effective for negative symptoms, such as emotional numbing, social withdrawal, apathy and loss of motivation, and less effective for positive symptoms such as hallucinations, delusions, confused thoughts and disorganized speech. The evidence is not strong enough in either direction to exclude the possibility that some forms of exercise may be beneficial for these more serious forms of mental illness, or to recommend it strongly. However, evidence is clear that increased exercise and physical activity can help to counteract the cardiovascular and metabolic illnesses that often increase disease and reduce lifespan in those with SMI.

## Mental Wellness

Finally, exercise and increased physical activity appear to be highly beneficial for many aspects of mental wellness, such as reducing stress, increasing self-esteem, and improving quality of life. These, along with results of studies with child and adolescent populations indicate that exercise and physical activity may play a protective role: reducing risk for mental illness, as well as helping to sustain mental wellness over time. Exercise may help to prevent mental illness through psychological (feeling better about oneself, coping with stress), biological (lower inflammation, increased brain-derived neurotrophic factor), and social pathways (playing sports or engaging in activities with others).

## Trends

What is the future of exercise? Several trends emerged from our review of the literature that deserve attention – in treatment and prevention of mental illness, promotion of mental wellness, and research:

- While stress-reduction is a universal goal in well-being research, some studies indicate that positive stress, or eustress, such as intense breathing and exposure to heat or cold may have mental health benefits.
- Exergaming, or gamification of exercise using video games (such as tennis or dance using handsets or mats), virtual reality (such as slicing or sword fighting), augmented reality (including stationary cycling with travel imagery or personal trainer images in the mirror) are proliferating and becoming immensely popular. It is possible that these exergames increase enjoyment, motivation, social and peer support, and may be biochemically rewarding and therefore reinforce new behaviors.
- Community-based exercise interventions, such as the “walking school bus” in which families walk kids to school together, hold promise for incorporating social and peer support, intergenerational wellness, and customizing exercise to be culturally-aligned.
- Green exercise includes physical activity or exercise that takes place outside, gardening, cycling, walking, horseback riding, flying kites, walking the dog or participating in a neighborhood garden. One study showed that the presence of water increased mental health benefits even more ([Roberts et al., 2017](#)).
- Affect-based exercise ([Ladwig et al., 2017](#)) is based on the premise that the primary goal of any exercise or physical activity plan should be to encourage lifelong activity. They suggest that in addition to tracking heart-rate or exertion, the assessment of enjoyment and pleasure (or discomfort/displeasure) could be just as important. Doing so has been shown to increase the amount of physical activity performed over a subsequent period of 6 months ([Williams et al., 2014](#)).

## Recommendations

### Research Recommendations

While the research literature is robust, several questions remain that are ripe for scientific investigation.

Across the field of research on exercise and mental health publications reporting on null or negative studies are rare. It may be that exercise and physical activity are overwhelmingly beneficial, and that the proportion of published studies with significant results reflects that. As the field progresses, it is important for both journal editors and scientists to publish negative or null results, even in brief reports, since it can be as beneficial to learn what does not work as to learn what does work.

The quality and rigor of studies varies widely, and data reporting is inconsistent. While small exploratory studies are an important part of the scientific process, underpowered studies with inadequate controls make it difficult to assess the value of exercise and physical activity interventions. The field would benefit from more frequently employing standardized exercise intervention protocols and reporting standards. In addition, emulating the [NIH Stage Model for Behavioral Intervention Guidelines](#) could accelerate the development of standard exercise protocols. Research can be improved by being more transparent about the characteristics of the exercise intervention, such as using a sport-science checklist ([Keller-Varady et al., 2018](#)). Like other scientific fields, we recommend that exercise and mental health studies pre-register hypotheses and methods, and participate in open science frameworks in which datasets are shared and analysis methods are transparent.

As one review ([Zhao et al., 2020](#)) concluded, future studies are urgently needed to establish accurate exercise prescriptions for improving depressive symptoms. Outside of clear recommendations for depression, the optimal F.I.T.T. (frequency, intensity, time and type) of exercise are unknown. Across the field, the ability to translate research findings into treatment recommendations is limited by widely varying protocols among studies in terms of duration, intensity, frequency, and length of exercise and physical activity protocols.

Is more always better, and is something better than nothing? While most cross-sectional and intervention studies indicated that higher intensity exercise is associated with lower depression, one study ([Paolucci et al., 2018](#)) randomizing college students to no, moderate, or high intensity exercise demonstrated a positive impact of both moderate and high intensity exercise on depression. However, high intensity exercise also increased stress and proinflammatory cytokines, perhaps due to the demand to exercise more, or strenuous exercise itself, producing higher levels of physical stress. Another study ([Helgadóttir et al., 2016](#)) randomized people with mild or moderate depression to treatment-as-usual, light exercise, moderate exercise, and vigorous exercise for 12 weeks. All three forms of exercise were superior to treatment-as-usual, but only light exercise showed reductions in depression at the 12-month follow-up. Furthermore, while more frequent and higher intensity and duration exercise results seem to have a beneficial impact overall, some research shows that even few amounts of weekly MVPA (1–74 min/week and 75–149 min/week) were associated with lower prevalence of depression, especially for men ([Werneck et al., 2018](#)).

Clearly the dose question is complex. The field has matured to a point where larger trials investigating 2-3 standardized F.I.T.T. variations for one condition at a time would be useful for creating clinical practice standards. In addition, studies investigating matching exercise F.I.T.T. to baseline patient characteristics (such as symptom severity, current activity levels, gender or age) are needed.

**Research recommendations arising from this report include:**

- **Optimal Dose:** Future research should investigate variations in frequency, intensity, type, and time (F.I.T.T.) or “dose” of exercise on mental health outcomes, and begin to converge on data-driven and consensus-based standards.
- **Translational Research:** For exercise types and mental health outcomes showing robust effects, pragmatic trials allowing scalable replication and implementation in routine practice are needed.
- **Mechanisms:** Identification of psychological mediators and biomarkers responsible for antidepressant/anxiety responses to exercise should be prioritized.
- **Follow-Up:** More studies with longer intervention and follow-up periods are needed to assess how and whether both exercise engagement, and symptom reductions, can be sustained over time.
- **Serious Mental Illness:** More research should focus on innovating types of exercise/physical activity that are feasible with people with serious mental illness, and investigate effects.
- **Treatment Matching:** A one-size fits all approach is unlikely to be successful. Future studies should focus on identifying subgroups based on symptoms and biopsychosocial characteristics to examine differential responses to exercise interventions ([Schuch et al., 2017](#))
- **Behavior Change:** Because of the disruptive nature of most mental disorders on regulation of energy levels and motivation, it may not be enough to simply recommend physical exercise (though this would be an improvement to the current standard of care). More research should focus on what stimulates motivation for increased physical activity and exercise, and what supports long-term lifestyle change.

An excellent meta-review ([Stubbs et al., 2018](#)) analyzing the results of systematic reviews and meta-analyses stringently selected for high quality on physical activity and serious mental illness (SMI) provides these additional expert-opinion recommendations for researchers:

- For all SMI groups, more research is needed into the effects of physical activity interventions during the pre-onset and early phases of illness;
- To optimize treatment ‘reach’, research should focus on establishing pragmatic, scalable methods for delivering physical activity as a treatment for SMI;
- Controlled trials of exercise for SMI should aim to determine the optimal dose-response of physical activity needed to treat SMI and should focus on implementation and culture in clinical practice;
- Research examining the effects of interventions to reduce sedentary behaviours and increase physical activity is needed;
- The underlying neurobiological mechanisms of physical activity in SMI are inadequately understood and require further investigation; and
- Long term and cost-effectiveness analyses of physical activity interventions are needed.

Finally, systematic evaluation of the quality of all or a subset of the articles included in this review would be a next step toward more precisely determining where each area of exercise-mental health research lies on that scale, and what needs to be done next. The articles in this review (or subsets of them) would benefit from being scored using the Physiotherapy Evidence Database (PEDro) (Maher et al., 2003) scale. The PEDro scale is based on the Delphi list, which is a set of 11 criteria for quality assessment including study eligibility, use of randomization, allocation concealment, similarity of groups at baseline, blinding of the subjects, therapists, and outcome assessors, use of intention-to-treat analyses, reporting of both point estimates and measures of variability of the primary outcome, adequacy of follow-up, and use of between-group statistical comparisons (all science terms to answer the question – how convincing is this evidence?). With such a quality assessment, the strength of evidence for each exercise type could be determined.

### **Clinical Recommendations**

While several countries have formally adopted exercise in their treatment guidelines for depression and other mental disorders and symptoms, the United States lags behind. For examples, Ekkakis and colleagues (2017) point out that: “Guidelines in the US do not presently recommend the use of exercise for treating depression at any level of symptom severity. The American Psychiatric Association (2010) provided no systematic review of evidence pertaining to exercise and did not mention exercise among its “Recommended Modalities for Treatment.”

### **Clinical recommendations emerging from this review of the scientific literature include:**

- **Depression.** People meeting criteria for depressive disorders should be prescribed 30-45 minutes of moderate to vigorous exercise 3-5 times per week, ideally beginning with structured group supervised exercise, or individual coaching by a physical therapist or fitness professional.
- **Anxiety:** Evidence supports prescribing yoga, qi gong, or mind-body movement for people experiencing symptoms of anxiety. Cardiovascular/aerobic and strength/resistance training should be encouraged and monitored for effectiveness.
- **Clinical Delivery:** Recommendations for exercise, physical activity, or movement for people experiencing mental illness symptoms should be accompanied by evidence-based support for behavior change, such as:
  - motivational interviewing
  - structured group and peer support
  - gradually increasing exercise duration and intensity
  - online and app-based tracking and reinforcement
  - behavior change coaching
- **Customization:** Adaptations of exercise interventions to be relevant to patient enjoyment, cultural and regional diversity should be explored. Without this, difficulty adhering to recommendations may backfire, increasing depression, stress or anxiety.

Our strong recommendation is that training or certification programs in the relationship between exercise/physical activity and mental health be developed and implemented in graduate-level mental health professional training programs, and in continuing education for already-licensed mental health care providers.

We also recommend that curricula and certification programs be developed for fitness professionals and occupational/physical therapists who wish to provide group or individual supervised exercise for mental health patients or community referrals from mental health providers. A goal would be for mental health professionals to more routinely incorporate exercise and physical activity into mental health care, supported by trained professionals in the community.

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## Appendix A – Search Strings

### Eligibility Criteria

In order to be included in the review, the following eligibility criteria was defined: The research must have been published between January 1, 1990 and December 31, 2019. Articles must have reported on the effect or relationship of at least one form of exercise, movement, or physical activity on or with at least one type of mental health condition or symptom attributed to mental illness. Studies were excluded if they did not contain at least one physical activity and one mental health outcome, did not yet have published results, or were not in English.

### Search String

We included the following search strings:

**May 2020**

**Pubmed search string:** <https://www.ncbi.nlm.nih.gov/pmc>

**Title only**

**Years: 1990-2019**

**Species: Human**

**2736 found**

Exercise or “Physical activity” or Cardio or “cardiovascular exercise” or “Weight training” or Yoga or Walking or Running or “Aerobic exercise” or Aerobics or “Circuit training” or “Weight lifting” or Cycling or Hiking or Running or “Skipping rope” or Swimming or Walking or Dancing or “Power walking” or “Anaerobic exercise” or Sports or Bodybuilding or “Eccentric training” or “Functional training” or Sprinting or “Strength training” or Stretching or “Altitude training” or Boxing or “Complex training” or “Cross training” or “Endurance training” or “Grip strength training” or “Interval training” or “Plyometrics” or “High intensity interval training” or “Resistance training” or “Training to failure” or “Pilates” or “Balance training” or “Flexibility training” or gyrotonics or “Tai chi” or “Tai Chi Chuan” or “Qi gong” or “Martial arts” or Karate

**And**

“Mental illness” or “Mental health” or “Alcohol use disorder?” or Alcoholism or “Substance Use Disorder?” or “Anxiety Disorder?” or “Generalized Anxiety Disorder?” or anxiety or “Panic Disorder?” or Phobia? or “Social Anxiety Disorder?” or “Adult Attention Deficit Disorder?” or “Attention Deficit Hyperactive Disorder?” or ADHD or ADD or “Bipolar Disorder?” or “Major Depressive Episode?” or “Hypomanic Episode?” or “Manic Episode?” or “Mixed Specifier?” or Depression or “Major depression” or “Clinical depression” or “Postpartum Depression” or “Seasonal Affective Disorder?” or “Eating Disorder?” or “Anorexia nervosa” or Anorexia or bulimia or “Bulimia nervosa” or “Obsessive-Compulsive Disorder?” or “Posttraumatic Stress Disorder?” or PTSD or Schizophrenia or “Mental wellbeing” or “Dissociative Disorder?” or “Depersonalization Disorder?” or “Binge Eating Disorder?” or “Alzheimer’s Disease” or Alzheimer’s or Dementia or “Personality disorder?” or “Dysthymic Disorder” or Dysthymia or “Borderline personality disorder?” or “Complex trauma” or “C-ptsd” or “Premenstrual dysphoric disorder?” or Pmdd



June 2020

Cochrane search string: <https://www.cochranelibrary.com>

Search Record Title

Word Variations have been searched

Date: 01/01/1990 – 12/31/2019

2699 found

(exercise OR Physical activity OR Cardio OR cardiovascular exercise OR Weight training OR Yoga OR Walking OR Running OR Aerobic exercise OR Aerobics OR Circuit training OR Weight lifting OR Cycling OR Hiking OR Running OR Skipping rope OR Swimming OR Walking OR Dancing OR Power walking OR Anaerobic exercise OR Sports OR Bodybuilding OR Eccentric training OR Functional training OR Sprinting OR Strength training OR Stretching OR Altitude training OR Boxing OR Complex training OR Cross training OR Endurance training OR Grip strength training OR Interval training OR Plyometrics OR High intensity interval training OR Resistance training OR Training to failure OR Pilates OR Balance training OR Flexibility training OR gyrotonics OR Tai chi OR Tai Chi Chuan OR Qi gong OR Martial arts OR Karate)

**AND**

(Mental illness OR Mental health OR Alcohol use disorder OR Alcoholism OR Substance Use Disorder OR Anxiety Disorder OR Generalized Anxiety Disorder OR anxiety OR Panic Disorder OR Phobia OR Social Anxiety Disorder OR Adult Attention Deficit Disorder OR Attention Deficit Hyperactivity Disorder OR ADHD OR ADD OR Bipolar Disorder OR Major Depressive Episode OR Hypomanic Episode OR Manic Episode OR Mixed Specifier OR Depression OR Major depression OR Clinical depression OR Postpartum Depression OR Seasonal Affective Disorder OR Eating Disorder OR Anorexia nervosa OR Anorexia OR bulimia OR Bulimia nervosa OR Obsessive-Compulsive Disorder OR Posttraumatic Stress Disorder OR PTSD OR Schizophrenia OR Mental wellbeing OR Dissociative Disorder OR Depersonalization Disorder OR Binge Eating Disorder OR Alzheimer's Disease OR Alzheimer's OR Dementia OR Personality disorder OR Dysthymic Disorder OR Dysthymia OR Borderline personality disorder OR Complex trauma OR C-ptsd OR Premenstrual dysphoric disorder OR Pmdd)

In August 2020, we searched for 3 additional terms in Pubmed:

<https://www.ncbi.nlm.nih.gov/pmc> – “movement therapy”, “dance”, and “fitness”:

**August 2020**

**Title only**

**Years: 1990-2019**

**Species: Human**

**7 results found**

(movement therapy[Title]) AND (“Mental illness”[Title] OR “Mental health”[Title] OR “Alcohol use disorder?”[Title] OR Alcoholism[Title] OR “Substance Use Disorder?”[Title] OR “Anxiety Disorder?”[Title] OR “Generalized Anxiety Disorder?”[Title] OR anxiety[Title] OR “Panic Disorder?”[Title] OR Phobia?[Title] OR “Social Anxiety Disorder?”[Title] OR “Adult Attention Deficit Disorder?”[Title] OR “Attention Deficit Hyperactivity Disorder?”[Title] OR ADHD[Title] OR ADD[Title] OR “Bipolar Disorder?”[Title] OR “Major Depressive Episode?”[Title] OR “Hypomanic Episode?”[Title] OR “Manic Episode?”[Title] OR “Mixed Specifier?”[Title] OR Depression[Title] OR “Major depression”[Title] OR “Clinical depression”[Title] OR “Postpartum Depression”[Title] OR “Seasonal Affective Disorder?”[Title] OR “Eating Disorder?”[Title] OR “Anorexia nervosa”[Title] OR Anorexia[Title] OR bulimia[Title] OR “Bulimia nervosa”[Title] OR “Obsessive-Compulsive Disorder?”[Title] OR “Posttraumatic Stress Disorder?”[Title] OR PTSD[Title] OR Schizophrenia[Title] OR “Mental wellbeing”[Title] OR “Dissociative Disorder?”[Title] OR “Depersonalization Disorder?”[Title] OR “Binge Eating Disorder?”[Title] OR “Alzheimer’s Disease”[Title] OR Alzheimer’s[Title] OR Dementia[Title] OR “Personality disorder?”[Title] OR “Dysthymic Disorder”[Title] OR Dysthymia[Title] OR “Borderline personality disorder?”[Title] OR “Complex trauma”[Title] OR “C-ptsd”[Title] OR “Premenstrual dysphoric disorder?”[Title] OR Pmdd[Title])

**Title only**

**Years: 1990-2019**

**Species: Human**

**43 results found**

(dance[Title]) AND (“Mental illness”[Title] OR “Mental health”[Title] OR “Alcohol use disorder?”[Title] OR Alcoholism[Title] OR “Substance Use Disorder?”[Title] OR “Anxiety Disorder?”[Title] OR “Generalized Anxiety Disorder?”[Title] OR anxiety[Title] OR “Panic Disorder?”[Title] OR Phobia?[Title] OR “Social Anxiety Disorder?”[Title] OR “Adult Attention Deficit Disorder?”[Title] OR “Attention Deficit Hyperactivity Disorder?”[Title] OR ADHD[Title] OR ADD[Title] OR “Bipolar Disorder?”[Title] OR “Major Depressive Episode?”[Title] OR “Hypomanic Episode?”[Title] OR “Manic Episode?”[Title] OR “Mixed Specifier?”[Title] OR Depression[Title] OR “Major depression”[Title] OR “Clinical depression”[Title] OR “Postpartum Depression”[Title] OR “Seasonal Affective Disorder?”[Title] OR “Eating Disorder?”[Title] OR “Anorexia nervosa”[Title] OR Anorexia[Title] OR bulimia[Title] OR “Bulimia nervosa”[Title] OR “Obsessive-Compulsive Disorder?”[Title] OR “Posttraumatic Stress Disorder?”[Title] OR PTSD[Title] OR Schizophrenia[Title] OR “Mental wellbeing”[Title] OR “Dissociative Disorder?”[Title] OR “Depersonalization Disorder?”[Title] OR “Binge Eating Disorder?”[Title] OR “Alzheimer’s Disease”[Title] OR Alzheimer’s[Title] OR Dementia[Title] OR “Personality disorder?”[Title] OR “Dysthymic Disorder”[Title] OR Dysthymia[Title] OR “Borderline personality disorder?”[Title] OR “Complex trauma”[Title] OR “C-ptsd”[Title] OR “Premenstrual dysphoric disorder?”[Title] OR Pmdd[Title])

**Title only**

**Years: 1990-2019**

**Species: Human**

**214 results found**

(fitness[Title]) AND (“Mental illness”[Title] OR “Mental health”[Title] OR “Alcohol use disorder?”[Title] OR Alcoholism[Title] OR “Substance Use Disorder?”[Title] OR “Anxiety Disorder?”[Title] OR “Generalized Anxiety Disorder?”[Title] OR anxiety[Title] OR “Panic Disorder?”[Title] OR Phobia?[Title] OR “Social Anxiety Disorder?”[Title] OR “Adult Attention Deficit Disorder?”[Title] OR “Attention Deficit Hyperactivity Disorder?”[Title] OR ADHD[Title] OR ADD[Title] OR “Bipolar Disorder?”[Title] OR “Major Depressive Episode?”[Title] OR “Hypomanic Episode?”[Title] OR “Manic Episode?”[Title] OR “Mixed Specifier?”[Title] OR Depression[Title] OR “Major depression”[Title] OR “Clinical depression”[Title] OR “Postpartum Depression”[Title] OR “Seasonal Affective Disorder?”[Title] OR “Eating Disorder?”[Title] OR “Anorexia nervosa”[Title] OR Anorexia[Title] OR bulimia[Title] OR “Bulimia nervosa”[Title] OR “Obsessive-Compulsive Disorder?”[Title] OR “Posttraumatic Stress Disorder?”[Title] OR PTSD[Title] OR Schizophrenia[Title] OR “Mental wellbeing”[Title] OR “Dissociative Disorder?”[Title] OR “Depersonalization Disorder?”[Title] OR “Binge Eating Disorder?”[Title] OR “Alzheimer’s Disease”[Title] OR Alzheimer’s[Title] OR Dementia[Title] OR “Personality disorder?”[Title] OR “Dysthymic Disorder”[Title] OR Dysthymia[Title] OR “Borderline personality disorder?”[Title] OR “Complex trauma”[Title] OR “C-ptsd”[Title] OR “Premenstrual dysphoric disorder?”[Title] OR Pmdd[Title])



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We do this by funding and promoting evidence-based research on how exercise, nutrition and mind-body practices benefit mental health resilience, supporting programs and initiatives that integrate evidence-based holistic approaches into the mental healthcare delivery system, and serving as a collaborative hub for an array of partners to advance a roadmap for an integrated approach to mental healthcare.

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