

Chapter 16

Physical Activity and Exercise for the Prevention and Management of Anxiety

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Chapter Overview

Anxiety disorders are a leading cause of the global disability burden. The mainstays of treatment for anxiety disorders are pharmacological and psychological interventions. Although a growing number of pharmacological treatments are available, about the half of patients do not respond adequately and require additional approaches for the prevention and treatment of anxiety disorders. Observational studies have demonstrated that physical activity is associated with a lower risk of incident anxiety at a population level. Randomized controlled trials have found that exercise, a subset of physical activity, can reduce anxiety and stress symptoms in people with anxiety disorders. The anxiolytic effect of exercise is observable following a single bout of exercise or a training program of aerobic and/or resistance training over several weeks. The mechanisms underlying the anxiolytic effects of exercise are not fully understood, but some neurobiological factors, such as changes on neurogenesis, inflammation, endocannabinoids, and regulation of the autonomic system, are potential candidates. In addition, psychological factors, such as reduction of anxiety sensitivity, increases in self-esteem, and mastery may help to explain this effect. In the present chapter, we provide an overview of the use of physical activity and exercise for the prevention and treatment of anxiety.

Physical Activity and Anxiety

Anxiety disorders are highly prevalent disorders in most cultures across the world (World Health Organization [WHO], 2017). In 2015, an estimated 3.6% of the global population had anxiety disorders. Some variation can be seen in different countries across the world, ranging from 2.2% (Vietnam) to 9.3% (Brazil; WHO, 2017). Anxiety disorders are the sixth leading cause of global disability with considerable economic costs (WHO, 2017).

The core features of anxiety disorders include persistent, intense, and excessive fear or worry (American Psychiatric Association [APA] 2013; WHO, 1992). Each disorder has its specific presentation, but the most common symptoms of anxiety across all disorders are feeling restless, wound-up or on-edge, fatigued, irritable, muscle tension, with difficulties concentrating, difficulties in controlling feelings of worry, and sleep problems. Although anxiety symptoms are present in daily life, for a clinical diagnosis these symptoms must (a) persist for a certain period of time, which varies from disorder to disorder (e.g., 6 months for generalized anxiety disorder [GAD]); (b) cause significant problems in areas of life (social interactions, school, and work); and (c) not be a consequence of substance use. The diagnosis must be made by a psychiatrist or psychologist. In addition to the profound burden on mental health and well-being, people with anxiety disorders experience poorer physical health (Firth et al., 2019). For example, people with anxiety disorders are at increased risk of cardiovascular disease (Batelaan et al., 2016), diabetes (Smith et al., 2018), and metabolic syndrome (Tang et al., 2017). Also, anxiety disorders are associated with a 77% increase in all cause-mortality risk and a 177% increase in cardiovascular mortality risk (Denollet et al., 2009).

The main treatments for people with anxiety disorders consist of antidepressants and psychotherapies (Katzman et al., 2014). While antidepressants are typically more efficacious than placebo (de Vries et al., 2018), the benefits are mostly modest for those with mild-to-moderate symptom severity, and eventually, the benefit-risk ratio may be unfavorable for these patients due to the side effects (de Vries et al., 2018). Also, adherence to antidepressant treatments is not optimal, and dropout rates can be four times higher compared to dropout with placebo pills (Cipriani et al., 2018) mostly due to common side effects, including weight gain, increased diabetes risk, and sexual dysfunction. Some of these side effects can potentially contribute to poor physical health for people with anxiety disorders. Psychological therapies, such as cognitive behavioral therapy, have moderate positive effects for people with anxiety disorders (Carpenter et al., 2018), but without improving physical health. In addition, dropout from psychotherapies can be up to 29%, which is substantially higher than control groups (17%; Carpenter et al., 2018).

Given the considerable individual and societal burden of anxiety disorders, there is an urgent need to identify modifiable risk factors and additional intervention strategies to mitigate this burden. Emerging evidence indicates physical activity (PA) and exercise can reduce the risk of developing anxiety disorders and be useful strategies for the treatment of anxiety disorders by reducing anxiety symptoms. In the present chapter, we provide a brief overview of the current evidence for (a) the role of PA and exercise as protective factors against incident anxiety, and (b) the use of PA and exercise as therapeutic strategies for people with anxiety disorders. We highlight the use of exercise as a strategy for acute management of symptoms, the effects of different types of exercise training, neurobiological mediators between exercise and anxiety, and issues related to exercise prescription, adherence, and dropout.

Can Physical Activity Protect Against Incident Anxiety?

Incident anxiety refers to the occurrence or development of new cases of anxiety. Cross-sectional studies have shown that people with higher levels of PA present a decreased risk of having anxiety. For example, cross-sectional evidence using data from the World Health Survey, accounting for 237,964 individuals from 47 countries, demonstrated that those with low levels of physical activity were

at 32% increased risk for having anxiety (odds ratio [OR], 1.32; 95% confidence interval [CI], 1.17–1.47; Stubbs, Koyanagi, et al., 2017). Also, meta-analytical findings reveal that those spending more time in sedentary behavior are 48% more likely to have anxiety, even when the analyses are adjusted for sociodemographic and health-related factors (OR, 1.48; 95% CI, 1.25–1.75; Allen et al., 2019).

A limitation of cross-sectional studies is the inability to infer directionality. However, these associations seem to be bidirectional. For example, there is a higher prevalence of low physical activity (da Silva et al., 2014; Stubbs, Koyanagi, et al., 2017) and high sedentary behavior in people with anxiety disorders (de Wit et al., 2011). Likewise, data from prospective cohort studies, which followed people free from anxiety for at least one year, demonstrate that people with higher self-reported PA levels are at 26% lower odds of developing meaningful anxiety symptoms and disorders (OR, 0.74; 95% CI, 0.62–0.88; Schuch et al., 2019). However, the evidence that PA protects against anxiety is mostly based on self-reported questionnaires that are more likely to suffer from social desirability and recall bias (Schuch et al., 2019). More recently, some evidence has shown that people with low cardiorespiratory fitness and muscular strength, two objectively assessed measures of physical capacity largely influenced by PA levels, have 60% higher risk (95% CI 1.14–2.11) of presenting anxiety compared to those with higher cardiorespiratory fitness and muscular strength (Kandola et al., 2020).

Exercise as a Treatment for Anxiety

Exercise can be used to alleviate anxiety symptoms in people with anxiety disorders. The effects of exercise on anxiety symptoms can be both acute, following a single bout of exercise, as well as chronic, following a period of weeks of intervention.

Acute Bouts of Exercise for Managing Symptoms

Current evidence has demonstrated that a single exercise bout results in a small reduction in state anxiety (Ensari et al., 2015). However, this notion has changed over the last five decades. In the 1970s, some believed that exercise would elicit increased anxiety symptoms in those prone to anxiety attacks/panic episodes (O'Connor et al., 2000). This fear seems to have been borne from an experiment conducted by Pitts and McClure (1967), who demonstrated that the infusion of sodium lactate induced symptoms of anxiety in people with anxiety neurosis. It is well-known that exercise results in an increased secretion of lactate. Therefore, the increase in lactate levels caused by exercise was thought to trigger panic attacks. This fear was reinforced because exercise results in bodily responses similar to somatic symptoms of anxiety, such as sweating, increased heart rate, and respiratory frequency. However, these findings were not supported by later evidence. A study in people with panic disorders observed only 5 panic attacks in 444 exercise bouts (1.13%) performed in the laboratory (O'Connor et al., 2000). In addition, further evidence has demonstrated that exercise is not only safe for people with panic disorders but also helps to alleviate acute state anxiety symptoms (Ströhle et al., 2009).

Exercise Training for Managing Symptoms

Diverse studies have attempted to discuss and meta-analytically synthesize the evidence on the anxiolytic effects of exercise training in healthy people (Conn, 2010), people with multiple chronic conditions (Herring et al., 2010), and people with anxiety disorders or elevated anxiety symptoms (Aylett et al., 2018; Bartley et al., 2013; Jayakody et al., 2014; Stubbs et al., 2017). Overall, small effects were observed for people with and without chronic health conditions (Conn, 2010; Herring et al., 2010). For people with anxiety disorders or elevated anxiety, there was some divergence in the magnitude and direction of the effects.

Bartley et al. (2013) synthesized data from seven randomized controlled trials and found no effect of exercise in people with anxiety disorders. However, this meta-analysis included studies comparing exercise versus relaxation plus paroxetine (Wedekind et al., 2010), strength exercises

(Martinsen et al., 1989), or cognitive behavioral therapy (Hovland et al., 2013). The inclusion of such studies in a meta-analysis is problematic because the control group “interventions” are largely effective. As such, to become effective, exercise effects would have to overcome the treatment effects of the control groups. For example, in the Wedekind et al. (2010) study, the authors compared the effectiveness of four interventions, namely (a) paroxetine + exercise; (b) paroxetine + relaxation; (c) placebo + exercise; and (d) placebo + relaxation, showing no differences between groups. However, all groups improved significantly and with a large effect on anxiety symptoms (paroxetine + exercise, Cohen’s $d = 2.33$; paroxetine + relaxation, Cohen’s $d = 2.00$; placebo + exercise, Cohen’s $d = 1.53$; placebo + relaxation, Cohen’s $d = 1.87$). In the study of Martinsen et al. (1989), aerobic exercise (walking and jogging) was compared to a combination of strength exercises, flexibility, and relaxation. At the end of the intervention, both groups improved without having any statistical differences between them. Lastly, Hovland et al. (2013) compared cognitive behavioral therapy versus exercise and found that cognitive behavioral therapy, a well-established and known intervention, is more effective than exercise for anxiety symptom reduction. The inclusion of such comparison groups likely results in a reduction of the estimated effect of exercise.

To address this, the authors explored the role of the type of control group in a subgroup meta-analysis, showing that exercise has a large effect compared to placebo or waitlist control groups. Stubbs et al. (2017) revisited the same topic in a more recent meta-analysis that included six randomized controlled trials. In this meta-analysis, studies did not include comparisons against other forms of exercise or other established treatments (e.g., antidepressants or psychotherapies). Stubbs et al. (2017) found a moderate effect of exercise on anxiety (SMD, -0.58; 95% CI -1.0, -0.76). The literature investigated the effects of exercise training in multiple anxiety disorders, and some heterogeneity in the effects can be observed across disorders. This can potentially mean that exercise may be more effective for some anxiety disorders compared to others. Due the small number of studies, it is not clear if the differences in the effects between studies are related to the diagnosis or to other methodological aspects, such as weekly frequency, exercise intensity and type, trial duration, comparison group, or other factors related to the sample, such as age, gender, symptom severity, or use of other treatments. For example, the seminal study lead by Broocks et al., (1998) found a very large effect of aerobic exercise on anxiety symptoms in patients with panic disorder. The exercise sessions were held three to four times per week, for eight weeks, while Herring et al. (2012) in another seminal study found a moderate effect of strength training, held two times per week, for 6 weeks in people with GAD. A brief summary of some existent studies by anxiety diagnosis is given in Table 16.1.

Exercise Prescription

The American College of Sports Medicine (ACSM) recommends the use of the frequency, intensity, time, and type (FITT) principle as a strategy to guide the exercise prescription (American College of Sports Medicine, 2013). However, the literature exploring how the FITT characteristics relate to the anxiolytic effects of exercise in people with anxiety disorders remains scarce.

Table 16.1*Randomized Controlled Trials on Exercise as a Treatment for Anxiety*

Study	Disorder	Sample	Exercise type	Frequency/ Duration	Add-on	Control/ comparison	Mental health outcomes
Abrantes et al. (2017)	OCD	<i>n</i> = 28 exercise/ <i>n</i> = 28 control	Aerobic Exercise	1x week/12 weeks	Usual treatment	Health Education	No differences between groups (both improved)
Bischoff et al. (2018)	PD	<i>n</i> = 39 Exercise group/ <i>n</i> = 38 control	Aerobic Exercise	2x week/6 weeks	CBT	Low-intensity exercise	↓Anxiety symptoms
Broocks et al. (1998)	PD	<i>n</i> = 16 Exercise group/ <i>n</i> = 15 placebo	Aerobic Exercise	3 to 4x week/8 weeks	None (monotherapy)	Placebo pill	↓Anxiety and depressive symptoms
Gaudlitz et al. (2015)	PD	<i>n</i> = 24 Exercise group/ <i>n</i> = 23 control	Aerobic Exercise	3x week/8 weeks	CBT	Low-intensity exercise	↓Anxiety symptoms
Goldstein et al. (2018)	PTSD	<i>n</i> = 21 Exercise group/ <i>n</i> = 26 control	Resistance Exercise + Aerobic exercise	3x week/12 weeks	About 40% of participants were taking psychiatric drugs	Waitlist control	↓PTSD symptoms

Table 16.1 (continued)

Herring et al. (2012)	GAD	<i>n</i> = 10 aerobic/ <i>n</i> = 10 resistance/ <i>n</i> = 10 control	Aerobic Exercise / Resistance Exercise	2x week/6 weeks	Some patients were also using antidepressants	Waitlist control	↓Worry symptoms
MarCom et al. (2008)	PD, GAD, SP	<i>n</i> = 38 exercise/ <i>n</i> = 36 control	Aerobic Exercise	Unknown frequency /9– 10 weeks	GCBT	Educational sessions	↓Anxiety, depressive, and stress symptoms
Plan et al. (2020)	GAD	<i>n</i> = 17 exercise/ <i>n</i> = 16 control	Aerobic Exercise (High intensity interval training)	Every second day/12 days	Stable doses of antidepressants and pregabalin were allowed	Low-intensity exercise	↓Anxiety, depressive, stress symptoms, somatic and worry symptoms
Powers et al. (2015)	PTSD	<i>n</i> = 5 exercise/ <i>n</i> = 4 control	Aerobic Exercise	1x week/12 weeks	ET	ET Alone	↓PTSD symptoms
Rosenbaum et al. (2015)	PTSD	<i>n</i> = 42 exercise/ <i>n</i> = 39 control	Resistance Exercise + Aerobic exercise (walking)	3x week/12 weeks	Usual treatment	Usual treatment alone	↓PTSD, depressive, stress symptoms

Note. Abbreviations: CBT = Cognitive Behavioral Therapy, ET = Exposure Therapy, GAD = Generalized Anxiety Disorders, GCBT = Group Behavioral Therapy, OCD = Obsessive Compulsive Disorder, PD = Panic Disorder, PTSD = Post-traumatic Stress Disorder, SP = Social Phobia

Most of the literature is based on aerobic exercises. However, a recent meta-analysis has shown that nonaerobic forms of exercise, such as resistance training, are also capable of reducing anxiety symptoms in healthy people and people with a chronic condition (Gordon et al., 2017). Early head-to-head trials comparing aerobic versus nonaerobic exercises found no difference between the two interventions (Martinsen et al., 1989). When taken together, there is evidence that both aerobic and nonaerobic exercises are effective.

The optimal dose of exercise intensity, frequency, or volume remains unclear. Most randomized controlled trials investigating this topic have shown the effectiveness of moderate-intensity exercise (Stubbs, Vancampfort, et al., 2017). Still, there is a paucity of trials investigating whether the same benefits could be achieved with lower intensities. The optimal weekly frequency and optimal weekly volume for achieving the greatest reductions in anxiety symptoms is also unclear.

In order to maximize exercise engagement and reduce dropout, clinicians and exercise professionals should consider that exercise should be rewarding and enjoyable, and autonomous motivation seems to be a key element for exercise engagement and maintenance (Vancampfort et al., 2015). Autonomous motivation leads someone to engage in exercise behavior for its own sake and intrinsic rewards, such as challenge and enjoyment (also see Chapter 3; Quested et al., 2021). Accordingly, every aspect related to the exercise prescription should consider personal preferences and make the exercise the most enjoyable. Hence, it might be viable to prescribe moderate exercise intensities or self-selected exercise intensities. For example, exercising at self-selected intensities and intensities below the ventilatory threshold are more likely to be linked to positive affective responses. In contrast, higher intensities are more likely linked to a negative affective responses in people with lower physical activity levels (Brand & Ekkekakis, 2018; also see Chapter 11 [Jones & Zenko, 2021]; Chapter 12 [Zenko & Ladwig, 2021]). In addition to intensity, it is also important to consider other personal preferences such as music listening, time of day, the presence of friends or family, and exercise setting. All these aspects should be considered and discussed with the exerciser. Including the exerciser in the decision-making process should increase the sense of autonomy (Vancampfort et al., 2015).

Potential Mediators (Mechanisms) of the Anxiolytic Effects of Exercise

Potential mechanisms underpinning the anxiolytic effects of exercise may be related to changes in biological markers and psychosocial/behavioral factors. Some biological markers are candidates to explain the effects of exercise. We do not intend to provide an exhaustive list; instead we briefly mention those with supporting evidence. It is believed that brain-derived neurotrophic factor (BDNF) potentially counteracts the impact of stress hormones on the hippocampus (Suliman et al., 2013). However, this protective mechanism seems to be impaired in people with anxiety, given that BDNF levels are reduced in this group (Carbone & Handa, 2013). Exercise, in turn, releases the secretion of BDNF in humans (Szuhany et al., 2015). A previous study has found an increase in BDNF serum levels following a single exercise bout (Strohle et al., 2010). However, no study has evaluated the BDNF response to long-term interventions in people with anxiety disorders (to the best of our knowledge). A second potential explanation is the exercise-related regulation of the autonomic system (AS) functioning. Some people with anxiety have impaired AS functioning, marked by decreased heart rate variability (Alvares et al., 2016). In turn, exercise improves AS functioning in patients with anxiety and AS dysfunction (Asmundson et al., 2013; Gaul-Aláčová et al., 2006). Lastly, the endocannabinoid hypothesis proposes that the endocannabinoid system is responsible for linking and integrating the perception of external and internal stimuli with psychological outcomes, such as anxiety, allowing the adaptation to its constantly changing environment (Lutz et al., 2015). Acutely, exercise promotes an increase on anandamide peripheral levels, an endocannabinoid in women with major depressive disorder, and this increase was associated with lower state anxiety (Meyer et al., 2019). However, there is a paucity of

studies showing that long-term anxiolytic effects of exercise are related to adaptations, instead of transient increases, in endocannabinoid levels.

One potential psychosocial mechanism relates to anxiety sensitivity. The systematic and deliberate exposure to somatic symptoms, such as increased heart rate, respiratory frequency, and sweating through exercise, has been shown to reduce the fear of bodily sensations related to anxiety (Smits et al., 2008). Second, physical activity and exercise have been associated with increased self-esteem, improved self-concept, and increased self-efficacy. For example, a study with young college women demonstrated that PA is inversely associated with symptoms of social phobia, GAD, and obsessive-compulsive disorders. Among the factors that explained these associations were self-concept and self-esteem (Herring et al., 2014). Lastly, exercise might lead to an increased sense of mastery and self-efficacy, especially when associated with marked increases in physical capacity and functioning, body composition changes, or when mastering a new set of techniques (Elavsky, 2010).

Conclusions

PA can reduce the risk of anxiety symptoms and disorders in the general population. In addition, among people with anxiety, acute and repeated exercise is safe and can alleviate symptoms. Exercise also has cardiovascular and metabolic benefits that may reduce the physical health risks that are associated with anxiety disorders. The mechanisms related to the anxiolytic effects of exercise are not fully understood but likely include both neurobiological and psychosocial factors. Exercise prescription should consider the participant's motivations, expectations, barriers, and preferences to promote autonomous motivation and long-term adherence.

Learning Exercises

1. Is physical activity associated with a reduced risk of incident anxiety? What is the magnitude of the effect?
2. Does exercise induce panic attacks?
3. Can exercise be used as a complementary treatment for anxiety disorders?
4. Explain how exercise could reduce anxiety.

Further reading

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