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Meta-analysis: Aerobic exercise for the treatment of anxiety disorders ☆

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ABSTRACT

Background: This meta-analysis investigates the efficacy of exercise as a treatment for DSM-IV diagnosed anxiety disorders.
Methods: We searched PubMED and PsycINFO for randomized, controlled trials comparing the anxiolytic effects of aerobic exercise to other treatment conditions for DSM-IV defined anxiety disorders. Seven trials were included in the final analysis, totaling 407 subjects. The control conditions included non-aerobic exercise, waitlist/placebo, cognitive-behavioral therapy, psychoeducation and meditation. A fixed-effects model was used to calculate the standardized mean difference of change in anxiety rating scale scores of aerobic exercise compared to control conditions. Subgroup analyses were performed to examine the effects of (1) comparison condition; (2) whether comparison condition controlled for time spent exercising and (3) diagnostic indication.
Results: Aerobic exercise demonstrated no significant effect for the treatment of anxiety disorders (SMD = 0.02 (95%CI: −0.20–0.24), z = 0.2, p = 0.85). There was significant heterogeneity between trials (χ^2 test for heterogeneity = 22.7, df = 6, p = 0.001). The reported effect size of aerobic exercise was highly influenced by the type of control condition. Trials utilizing waitlist/placebo controls and trials that did not control for exercise time reported large effects of aerobic exercise while other trials report no effect of aerobic exercise.
Conclusions: Current evidence does not support the use of aerobic exercise as an effective treatment for anxiety disorders as compared to the control conditions. This remains true when controlling for length of exercise sessions and type of anxiety disorder. Future studies evaluating the efficacy of aerobic exercise should employ larger sample sizes and utilize comparison interventions that control for exercise time.

1. Introduction

Anxiety disorders rank among the most common mental health disorders in the developing world (Merom et al., 2008). In the US the lifetime prevalence rate of anxiety disorders is estimated to be as high as 28.8%, with about 40 million people meeting the criteria for diagnosis (Kessler et al., 2005). Research has also shown that anxious patients have a higher risk of developing various co-morbid conditions such as depression, substance use disorders, and cardiovascular disease, while also utilizing more healthcare visits and resources than the general population (Merom et al., 2008; Strik et al., 2003; Vogelzangs et al., 2010). Current treatments for anxiety disorders include pharmacotherapy with serotonin-reuptake-inhibitors and cognitive behavioral therapy (CBT) (Taylor et al., 2012). Although pharmacotherapy has demonstrated efficacy in the treatment of anxiety disorders, there are significant side-effects. Common side-effects of pharmacotherapy for anxiety disorders include sexual dysfunction, sedation, insomnia, and nausea (Black, 2006; Corona et al., 2009). Less common but more serious side-effects of pharmacotherapy include new-onset suicidal ideation, cardiac arrhythmias and increased risk of bleeding disorders (Black, 2006; Corona et al., 2009). Treatment with pharmacotherapy also carries the possibility of relapse after discontinuation and thus may not be an adequate long-term solution for some patients (Broocks et al., 1998). Psychotherapy as a treatment for anxiety also has its problems such as high cost, at times patient resistance and lack of access to qualified therapists (Black, 2006). CBT has been shown to be an especially effective form of psychotherapy treatment for anxiety, though positive results are reached only after several treatment sessions and many patients have difficulty adhering to this treatment regimen (Merom et al., 2008).

Abbreviations: CBT, Cognitive Behavioral Therapy; DSM, Diagnostic Statistical Manual; SMD, Standardized Mean Difference; GAD, Generalized Anxiety Disorder; PD, Panic Disorder; CI, Confidence Interval; MBSR, Mindfulness–Based Stress Reduction; LSAS-SR, Liebowitz Social Anxiety Scale-Self Report; STAI-Trait, State-Trait Anxiety Inventory; P&A, Panic & Agoraphobia Scale; CGI, Clinical Global Impression Scale; DASS, Depression Anxiety Stress Scale; HAM-A, Hamilton Anxiety Rating Scale; CPRS, Comprehensive Psychopathological Rating Scale; PARS, Phobic Avoidance Rating Scale; ACQ, Agoraphobia Cognitions Questionnaire.

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Exercise has been studied as a possible treatment option for anxiety symptoms and disorders, both as an adjunctive treatment (with pharmacotherapy or psychotherapy), and by itself (Broocks et al., 1998; Herring et al., 2011; Hovland et al., 2012; Jazaieri et al., 2012; Martinsen et al., 1989; Merom et al., 2008; Wedekind et al., 2010). In addition to general health benefits, exercise has also been reported to help poor concentration, fatigue, feelings of depression, muscle tension & pain, irritability, and other general symptoms and feelings of anxiety (Herring et al., 2011). In an uncontrolled study with patients diagnosed with anxiety and/or depressive disorders, acute exercise lasting for as little as 20 min was demonstrated to improve anxiety levels (Knapen et al., 2009). Similarly, a trial looking at a specific neurotrophic factor that has been linked with depression and anxiety found that acute exercise reduced the concentrations of the neurotrophic factor in the brains of participants with panic disorder (Strohle et al., 2010).

Several meta-analyses have examined the possible benefits of exercise on mental health, however the majority have focused on treating depression rather than anxiety disorders (Krogh et al., 2011; Rethorst et al., 2009; Stathopoulou et al., 2006). A previous meta-analysis has examined the efficacy of aerobic exercise for reducing anxiety symptoms in healthy participants, but not in individuals with diagnosed anxiety disorders (Conn, 2010). This meta-analysis reported a small but significant benefit of aerobic exercise in reducing anxiety symptoms but reported a large amount of heterogeneity between studies (Conn, 2010). In exploratory moderator analysis, larger anxiety improvement effect sizes were found among studies that included larger samples, targeted only physical activity behavior instead of multiple health behaviors, included supervised exercise, used moderate- or high-intensity instead of low-intensity physical activity, and suggested participants exercise at a fitness facility (vs. home) following interventions (Conn, 2010).

Another comprehensive systematic review in the area examined the efficacy of exercise on anxiety symptoms (and specifically in anxiety disorders). This systematic review touted "a growing body of evidence indicating promise for exercise as an effective treatment for some of the anxiety disorders," however, the authors relied on individual discussion of trials rather than meta-analysis to draw their conclusions (Asmundson et al., 2013, p. 362). The goal of this meta-analysis is to analyze current studies to determine the efficacy of long-term exercise as a treatment for anxiety disorders. We will also examine the moderating effects of the type of anxiety disorder, type of comparison condition, and whether the comparison condition controlled for time spent exercising on the reported efficacy of aerobic exercise between studies.

2. Methods

2.1. Search strategy

Two reviewers (CB and MH) searched PubMed (1965–January 2013) and PsycINFO for relevant citations. Within PubMed, we used the search terms "Anxiety Disorders and Exercise (MESH)" and further limited to randomized controlled trials. Our search in PsycINFO was conducted using the keywords "Anxiety Disorders and Exercise" and limiting the search to empirical studies using the methodology filter. The references of related review articles, meta-analyses and included articles were also searched for additional eligible citations. There was no language limitations placed on studies.

2.2. Inclusion criteria

Trials were included in our meta-analysis if they were randomized, controlled trials assessing the effect of exercise as a treatment for anxiety disorders (as defined by DSM criteria but excluding post-traumatic stress disorder). Trials were excluded if they did not include a control condition, if they did not have multiple exercise sessions, if they included subjects without a primary diagnosis of an anxiety disorder, or did not include outcome measures examining changes in anxiety symptoms. Randomized controlled trials were identified if the investigator defined them as such in the Methods section of the article.

2.3. Meta-analytic procedures

To extract data from included articles, we used Excel™ spreadsheets. Data extracted included the type of intervention (e.g. biking, walking or running), type of comparison condition (e.g. waitlist, placebo, cognitive-behavioral therapy, psychoeducation, non-aerobic exercise, medication or other), number and length of exercise sessions, sample size, age of sample, type of anxiety disorder in subjects and the primary measure utilized for anxiety.

Our primary outcome measure was mean improvement in the primary rating scale used to measure anxiety in the trial. We examined the difference between aerobic exercise and comparison condition by calculating the standardized mean difference (SMD) using Comprehensive Meta-Analysis (Biostat, Englewood, NJ). This measure was favored over weighted mean difference, because rating scales differed between the included studies. For the primary outcome examining the efficacy of aerobic exercise trials that compared aerobic exercise to medications (or therapies) with known efficacy for anxiety disorders were excluded. We did this because the measured efficacy of aerobic exercise compared to treatments previously demonstrated to be effective (e.g. antidepressants, cognitive behavioral therapy) would be different than control conditions that are ineffective (i.e. placebo/waitlist). Comparing exercise to an effective treatment would systematically underestimate the effect size of the intervention. When trials compared aerobic exercise to multiple comparison groups (e.g. non-aerobic exercise and waitlist) the control group that best accounted for subject time was included in the primary analysis. This decision was made, when possible, to control for the fact that focused time and effort on any activity hypothesized to help anxiety might have a positive effect on reducing severity when compared to a control condition that involved no time or effort (i.e. waitlist). We used a fixed effects model for meta-analysis but report results for random-effects model in a sensitivity analysis.

Publication bias was assessed by plotting the effect size against standard error for each trial (funnel plot) (Egger et al., 1997). In addition, publication bias was statistically tested by the Egger's test and by determining the association between sample size and effect size in meta-regression (Egger et al., 1997). Heterogeneity between trials was determined by means of two separate statistical estimates using Comprehensive Meta-Analysis. First, a *Q*-statistic was employed to provide a test of statistical significance indicating whether the differences in effect sizes are due to subject-level sampling error alone or other sources. In addition, we estimated heterogeneity using *I-square* statistic, which estimates the proportion of total variance that is attributable to between-study variance.

For secondary analyses we performed several subgroup analyses. Stratified subgroup analysis in Comprehensive Meta-Analysis was used to assess the effects of (1) comparison condition (non-aerobic exercise, CBT, waitlist/placebo and other [psychoeducation or meditation]); (2) whether comparison condition controlled for time spent exercising; and (3) diagnostic indication (generalized anxiety disorder, social phobia, panic disorder or other anxiety disorder). We also conducted an additional meta-analysis comparing aerobic exercise to antidepressant medication. We planned to perform additional stratified meta-analyses and meta-regressions to examine the type of exercise intervention, length of exercise session, and duration of trial, but there was either too poor description or too little variation between trials to conduct meaningful analysis. Our threshold for statistical significance was selected to be $p < .05$ for the primary analysis, as well as for all subgroup analyses. Any significant findings in secondary analyses should be regarded as exploratory because we did not adjust for inflation of false-positive error from our four secondary analyses.