Revista Brasileira de Psiquiatria. 2016;38:255–261
Associação Brasileira de Psiquiatria
doi:10.1590/1516-4446-2015-1893

REVIEW ARTICLE

The effects of regular physical activity on anxiety symptoms in healthy older adults: a systematic review

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Objective: Anxiety symptoms are common in older adults with or without anxiety disorders. Pharmacological options may be limited for these patients. Alternative treatments, such as physical activity (PA), are often indicated, although few trials have evaluated their efficacy. The aim of this review was to evaluate the efficacy of regular PA on improving anxiety symptoms in older adults without anxiety disorders. Potential neuroendocrine, inflammatory, and oxidative mechanisms, as well as cognitive factors to explain these effects are also discussed.
Methods: A systematic literature review was performed to identify randomized controlled trials, cross-sectional, cohort, and case-control studies, as well as case series including healthy previously sedentary older adults. We searched the PubMed and Web of Science databases for articles published in English, with no set time limits.
Results: Eight studies evaluating the effect of PA on anxiety symptoms in healthy older adults were included in this review. In all studies, regular and supervised PA was directly related to decreased anxiety symptoms in older individuals.
Conclusion: Regular PA may be effective for improving anxiety symptoms in older adults. More studies are needed to identify the ideal PA modality, frequency, duration, and intensity for optimizing the positive effects of exercise on anxiety in this population.

Keywords: Physical exercise; anxiety; aged

Introduction

Anxiety can be defined as a set of physiological and behavioral responses that protect individuals from danger.[1] Nonetheless, anxiety is also clinically defined as an unpleasant, subjective state of vague and diffuse apprehension that is often accompanied by physical sensations, such as sweating, muscle tension, tremors, and tachycardia, among others.[2] Thus, although anxiety may be a valuable mechanism of protection, an anxiety response that is disproportionate to the threat or stimulus may lead to functional impairment, with impact on the personal and professional lives of those affected.[1] According to the DSM-5,[3] anxiety disorders can be categorized into generalized anxiety disorder (GAD), panic disorder (PD), agoraphobia, specific phobia, social anxiety disorder, separation anxiety disorder, and selective mutism. Anxiety scales may be used to assess sub-threshold anxiety symptoms (i.e., excessive worry and fear, chronic apprehension, or somatic anxiety symptoms, such as dyspnea, chest pain, and tachycardia) in individuals who are not diagnosed with a specific anxiety disorder. The Hamilton Anxiety Rating Scale (HAM-A) and the State-Trait Anxiety Inventory (STAI) are the two most commonly used scales to assess anxiety symptoms.[4,5] Although having a better prognosis than threshold anxiety disorders, sub-threshold anxiety has also been linked to impairment in psychosocial and work functioning as well as increases in benzodiazepine and primary health care use.[6,7] These sub-clinical conditions may also increase the risk of onset of a range of comorbid mental health, pain, and somatic disorders, or worsen the course of these conditions.[7]

There are several difficulties in diagnosing anxiety disorders in the elderly, which ultimately delay or prevent recognition of this disorder. Primary challenges include the fact that anxiety, fear, and concerns are often normal in this age group, that older individuals frequently have difficulty completing questionnaires, and that the prevalence of subclinical symptoms is high in this population.[8] Even though the prevalence of anxiety disorders in older adults is lower as compared to younger adults, many older adults report anxiety symptoms.[8,9] Thus, it is possible that the presence of sub-threshold anxiety disorders among older adults is not fully recognized.[9]

In addition to the barriers to diagnosing anxiety disorders and sub-threshold anxiety symptoms in the elderly, pharmacological treatment for older adults may be hampered by several factors, including clinical comorbidities, slower drug metabolism, and drug interactions due to polypharmacy, which is commonly seen in these patients.[8] Thus, non-pharmacological treatments are often employed, such as psychotherapy, relaxation techniques, and physical activity (PA).

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Submitted Dec 15 2015, accepted Mar 29 2016.

Several meta-analyses and systematic reviews have shown the benefits of different modalities of PA for younger adults with both anxiety disorders and anxiety symptoms.[10-13] A recent review of randomized controlled trials (RCTs) evaluating the effect of PA as a treatment for patients with either a diagnosis of anxiety disorder or elevated anxiety symptoms concluded that PA is effective compared to placebo and similar to other treatment modalities, even though most studies had significant methodological limitations.[10] The study also included previous meta-analyses focusing on anxious patients and subjects without a diagnosis of anxiety disorder. Of the five meta-analyses included, four concluded that exercise is an effective treatment for anxiety, with effect sizes ranging from 0.22 (small) to 0.56 (moderate).[10] The meta-analysis by Conn et al.,[11] which was the only one including participants without anxiety disorders, found a small, but significant benefit (effect size = 0.22) of exercise to reduce anxiety symptoms in healthy adults. It also concluded that the results are superior for moderate to high-intensity PA than for low-intensity exercise (an effect size of 0.11 for low intensity vs. 0.45 for moderate to high intensity). The studies included in that meta-analysis did not specify what constituted low, moderate, and high PA intensities or how they were measured. Furthermore, supervised PA had better effects than unsupervised PA (effect sizes 0.47 vs. -0.93). There was no difference between studies that applied only aerobic PA compared to aerobic or flexibility PAs.[11]

A meta-analysis by Bartley et al.[12] did not find significant differences between the exercise and control conditions for anxiety outcomes (effect size = 0.02). Those authors evaluated the effect of aerobic exercise in patients with various anxiety disorders (i.e., PD with or without agoraphobia, GAD, and social phobia). However, when the analyses were restricted to studies comparing exercise to placebo or waitlist controls, exercise had a significant effect (standardized mean difference [SMD] = 1.42, 95% confidence interval [95%CI] 0.80-2.04). The effects of aerobic PA were compared to the effect of other therapeutic interventions and non-aerobic PA as secondary outcomes. The effect of PA effect was also examined in different anxiety disorders. There was no significant difference between aerobic and non-aerobic PA (SMD = -0.28, 95%CI -0.76-0.20), which included strength training, flexibility, or relaxation exercises and varied between studies. The effect of PA was similar for the different anxiety disorders assessed.[12]

Jayakody et al.[13] also carried out a systematic review to evaluate the effect of PA on anxiety disorders, and found that PA was effective as an adjunctive therapy (associated with pharmacotherapy and cognitive-behavioral therapy). No difference was detected between aerobic and non-aerobic PAs. There are no standards regarding the most effective intensity of exercise to reduce symptoms in anxiety disorders. According to Sexton et al.,[14] high-intensity exercise, such as jogging, was superior to light or moderate exercise, such as walking, but this result was not statistically significant.

The anxiolytic mechanisms of PA are not entirely clear. However, several hypotheses have been postulated to explain the observed effects. Abnormalities in conditioned fear processing are central to the pathophysiology of several anxiety disorders.[15] Exaggerated activation of the neurocircuitry of fear engenders a state of chronic stress that may produce several harmful effects, which, in turn, lead to anxiety disorder perpetuation. These effects include: hypothalamic, pituitary, adrenal (HPA) axis activation and consequent cortisol production, increased levels of pro-inflammatory cytokines, such as interleukin (IL)-1, IL-6, tumor necrosis factor-alpha and interferon-gamma, and reactive oxygen and nitrogen species production.[16] This chronic pro-inflammatory state causes a reduction in the levels of neurotrophins, including brain-derived neurotrophic factor (BDNF), which negatively affects brain neurogenesis and neuroplasticity.[16]

PA may regulate the HPA axis, reduce the sympathetic nervous system hyperactivity that is seen in patients with anxiety disorders, and increase parasympathetic function.[17] Research has demonstrated that regular PA enhances anti-inflammatory mechanisms, with increases in the levels of anti-inflammatory cytokines, such as IL-10 and IL-1 receptor antagonist.[9] Several studies have reported that regular, moderate PA reduces markers of oxidative stress, potentially through an increase in antioxidant enzyme activity.[9] PA has been shown to induce increases in mitochondrial uncoupling protein 2 (UNCP2), which has been demonstrated to increase the production of adenosine triphosphate and decrease superoxide production.[9] The effects on energy metabolism appear to underpin the many positive PA-induced effects on neurogenesis and brain plasticity.[16] Thus, PA appears to exert anxiolytic effects by providing protection from toxic inflammation and oxidative stress, potentially by promoting neurotrophins and anti-inflammatory and antioxidant activity in key brain regions. Therefore, PA may help regulate normal processes of neurogenesis, neuroplasticity, and apoptosis.[16] The protective effects of PA on neurogenesis have been demonstrated through increases in neurotrophic factors, including BDNF and insulin-like growth factor-1 (IGF-1) levels.[16-18]

Alternative hypotheses have also been proposed for the anxiolytic effects of PA on activating the endocannabinoid system[19,20] and modulating adenosine receptors.[21] PA increases circulating levels of endocannabinoids, including anandamide.[19,20] In turn, these neuromodulators induce antianxiety and antidepressive effects by regulating the signaling of other neurotransmitters (i.e., dopaminergic and glutamatergic signaling) and reducing metabolism in the pre-frontal cortex.[19,20] Cannabinoids may also have anxiolytic effects by regulating the HPA axis and enhancing BDNF expression.[19] The intense psychological experiences that are elicited by activating endocannabinoid receptors are strikingly similar to the "runner's high," - including analgesia, sedation, reduced anxiety, euphoria, and difficulty estimating the passage of time.[20] It is also known that this nucleotide plays an important role in regulating blood flow, synaptic transmission, and neuronal excitability in the adenosine system.[21] Studies with rats[21,22] show increased adenosine concentrations in the entire brain as well as increased hippocampal adenosine receptors (A2A) after aerobic exercise

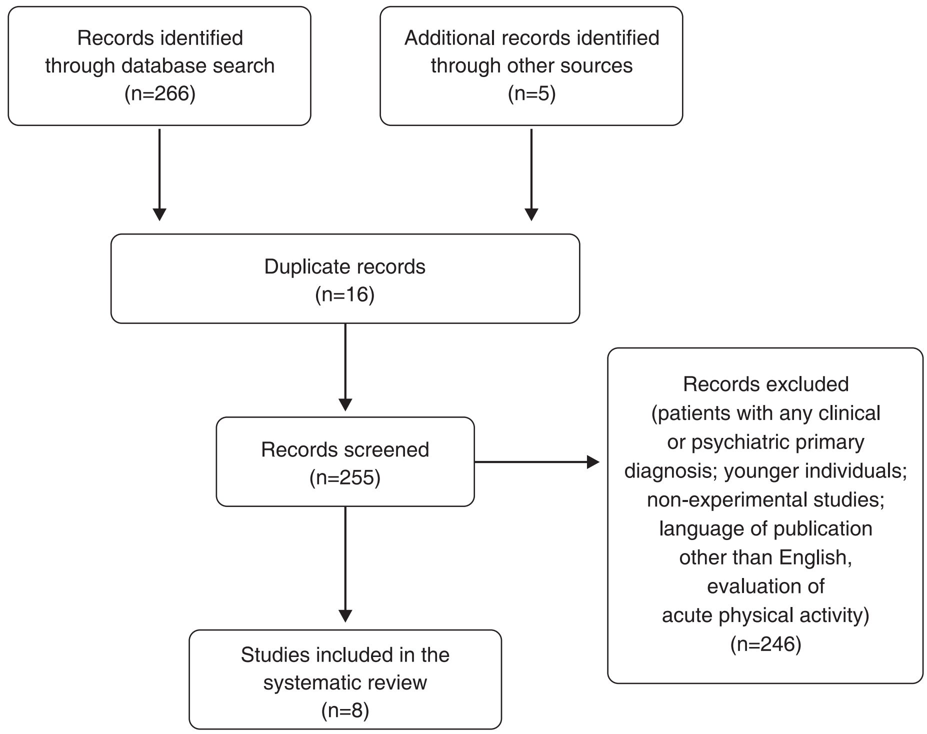

Figure 1 Flowchart of search and selection of articles.

with a simultaneous decrease in anxiety-related behavior and sleep pattern improvements.[21,22]

Finally, several studies have demonstrated that aerobic exercise is effective in reducing high sensitivity to anxiety (i.e., the propensity to fear anxiety sensations based on appraisals that they will lead to catastrophic consequences), a trait that is characteristic of most anxiety disorders. This result may reflect a type of interoceptive exposure, because it evokes physiological changes, such as elevated heart rate, muscle tension, shortness of breath, and sweating, which mimic anxiety responses. Like other interoceptive exposure strategies, PA may facilitate habituation to bodily sensations that normally trigger anxiety and panic symptoms in a controlled and safe manner, dissociating them from the subjective experience of anxiety and consequent catastrophic interpretations.[17]

Physical exercise appears to be an effective alternative treatment for anxiety symptoms in younger patients with or without diagnosed anxiety disorders. However, only limited data are available for older populations, and no systematic reviews focusing on this group have been conducted so far. Thus, we performed a systematic review of the literature evaluating the efficacy of PA for improving anxiety symptoms in older adults, hypothesizing that it would be similar to the efficacy reported for younger individuals.

Methods

In this systematic literature review, PubMed and Web of Science databases were searched for RCTs, cross-sectional, cohort, and case-control studies, and case series evaluating the effect of PA programs on anxiety symptoms in healthy previously sedentary older adults (without a diagnosed anxiety disorder). The keywords (medical subject headings) utilized for the search were anxiety, physical exercise, and aged. Only studies published in English were considered, but no time limits were set. Studies evaluating patients with any primary medical or psychiatric disorder were excluded. Studies with other designs, e.g. review articles and meta-analyses, as well as those evaluating the effect of acute PA rather than regular PA during the follow-up were also excluded. The references of selected studies were manually searched for additional articles.

Results

The search of databases yielded 265 articles, and five additional articles were identified in the manual reference check. Of these 271 studies, we excluded 16 duplicate records, 19 articles written in languages other than English, 192 articles evaluating patients with a primary psychiatric or medical condition or focusing on younger adults, and 18 papers not reporting experimental studies (i.e., review articles or meta-analyses). An additional 18 articles were excluded for evaluating the effect of acute PA rather than regular PA. Thus, eight studies were included in this review (Figure 1).

The quality of the studies included was assessed during the selection process considering risk of bias (selection, performance, detection, and attrition bias). However, because very few studies met the inclusion criteria, all were included, despite their bias potential. Of eight studies, five were RCTs, two were cross-sectional studies, and one was a cohort study. Table 1 shows the quality

Table 1 Quality assessment of the randomized controlled trials included

Study	Sample size (n)	Randomization method	Comparable groups	Double-blinding	Dropouts (absolute number)
Antunes et al.[23]	46	Unclear	Yes	No	0
Tsutsumi et al.[24]	42	Unclear	Yes	No	1
Cassilhas et al.[25]	43	Unclear	Yes	No	0
Katula et al.[26]	80	Unclear	Yes	No	1
Zhang et al.[27]	150	Unclear	Yes	No	6*

* 2, 3, 1, 0, 0, respectively for each group.

analysis of the five RCTs considering sample size, randomization method, comparability between groups, double-blinding, and dropout rate. Neither subjects nor investigators were blinded in any of the RCTs, which can be explained by the nature of the intervention (PA).

Cross-sectional studies

One cross-sectional study by Cassidy et al.,[28] focusing on community-based women aged 70 years and over (n=278; mean age = 74.6 years), evaluated the association between modifiable lifestyle variables (i.e., smoking, alcohol consumption, PA, nutrition, and education) and mental health (i.e., depression, anxiety, quality of life, and cognitive function). Anxiety and depression symptoms were evaluated by the Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI). The Cambridge Cognitive Examination for Mental Disorders of the Elderly (CAMCOG) evaluated cognitive functioning, and the Short Form 36 Health Survey (SF-36) assessed health-related quality of life. Patients were categorized as physically active if they reported three or more cumulative hours of PA per week (ranging from light exercise, such as walking the dog to vigorous exercise, such as aerobics). Otherwise, participants were considered to be physically inactive. The study showed that physically active women were half as likely to present anxiety (defined by BAI $\geqslant$ 8) and depression symptoms (defined by BDI $\geqslant$ 10) compared to the physically inactive group (both odds ratio = 0.5, 95%CI 0.3-0.8). Participants who had ever smoked more than 20 cigarettes per day were at increased risk for depression and moderate alcohol consumption, while participants who had higher education levels had higher CAMCOG scores. There was no relationship between vitamin B12/folate deficiencies or obesity and the outcome measures.[28]

A second inventory was conducted by McHugh & Lawlor,[29] who interviewed 583 community-based adults aged 60 years or more. The aim of that study was to evaluate the correlation between hours of PA per week, social support, and psychological distress (i.e., depression symptoms, anxiety symptoms, and perceptions of stress). The Center for Epidemiologic Studies Depression Scale (CESD-8) was used to assess depressive symptoms, the Hospital Anxiety and Depression Scale - Anxiety Subscale (HADS-A) was used to assess anxiety symptoms, and the Perceived Stress Scale was used to assess stress experienced in the previous month. These scores were correlated to the number of hours per week spent exercising (i.e., walking, jogging, cycling, swimming, aerobics, tennis, dancing, golf, yoga, bowling, judo, Gaelic football, horse riding, rugby, badminton, tai chi, and sailing). Social support was evaluated with the Lubben Social Network Scale and was also correlated with the number of hours of PA per week as well as psychological distress. Thus, the authors investigated the extent to which exercise and social support independently predicted cross-sectional psychological outcomes. Both PA and social support from friends were independently related to lower anxiety, depression, and perceived stress scores ($p < 0.001$). PA appeared to protect against the effect of low social support on depression. Potential confounders, including age, gender, pain, activities of daily living, instrumental activities of daily living, the Age-Adjusted Charlson comorbidity index, and neuroticism were controlled for in the analyses.

Cohort studies

In a prospective study by Bäckman et al.,[30] a cohort of former Finnish male athletes (n=504) and referent subjects (n=349) were followed up to investigate the relationship between changes in PA and subsequent self-reported mood and daily living functioning in 1985, 1995, and 2001. The cohort included 2,448 male athletes who represented Finland at least once in international or inter-country events between 1920 and 1965; the cohort's mean age was 68.6 years in 2001. Mood and anxiety symptoms were evaluated with two Brief Symptom Inventory-53 (BSI-53) subscales. PA levels in 1985 were associated with mood, anxiety symptoms, and daily living functioning in 1995 and 2001. Additionally, an increase in PA between 1985 and 1995 protected against the onset of anxiety between 1995 and 2001. In contrast, low levels of PA at baseline predicted poor physical functioning at the end of the study.

Randomized controlled trials

Several RCTs have been developed to analyze the effects of PA on anxiety symptoms in healthy but sedentary older adults. These studies explore different types of PA, including aerobic exercise, strength exercise, or mixed activities.

Antunes et al.[23] evaluated 46 sedentary seniors aged between 60 and 75 years who were randomly assigned to an experimental group and a control group. Experimental group members participated in an aerobic fitness program that consisted of ergometer cycle sessions three times a week on alternate days for 6 months, working at a heart rate corresponding to the ventilatory threshold-1 intensity. Subjects were evaluated for anxiety symptoms with the

STAI, for depressive symptoms with the Geriatric Depression Scale (GDS), and for quality of life with the SF-36. A significant decrease in depressive and anxiety scores and improvements in quality of life were found in the experimental group ,with no significant changes in the control group.

Two studies analyzed the effect of strength (or resistance) exercise on anxiety symptoms in older patients. The first was published in 1997 by Tsutsumi et al.[24] and evaluated the effects of high and low-intensity strength exercises on muscular fitness, psychological effect, and neurocognitive function in 42 older adults (mean age = 68 years). Patients were randomly assigned to a high-intensity/low-volume 12 week-program (2 sets of 8-10 repetitions at 75 to 85% of 1 repetition maximum [RM]), a low-intensity/high-volume 12 week-program (2 sets of 14-16 repetitions for 55 to 65% of 1 RM), or no exercise control program. The Profile and Mood States (POMS) and the STAI trait/state inventory were used to evaluate changes in mood and anxiety states. Strength-trained subjects had improvements in mood and trait anxiety compared to those who did not participate in the PA program. There were no significant differences between the low and high-intensity subgroups on anxiety scores.

A second study by Cassilhas et al.[25] was conducted in 2010 and included 43 elderly men aged between 65 and 75 years who were randomly assigned to con-trol or high resistance exercise groups. The exercise program consisted of three, 1 hour sessions per week, on alternating days for 24 weeks, in which patients completed two sets of eight repetitions each for 80% of 1 RM. During the intervention, three 1 RM tests were conducted to adjust for training overload at weeks 15, 18, and 21. This study also evaluated IGF-1 serum levels before and after the PA program, which were hypothesized to be associated with improvements resulting from PA on mood and anxiety symptoms. The exercise group had lower state and trait anxiety than the control group after the 24 weeks of training (evaluated by the STAI) and showed improvements in mood as shown by lower mean scores on all four Visual Analogue Mood Scale (VAMS) measures (anxiety, physical sedation, mental sedation, and other feelings and attitudes). The experimental group also showed higher IGF-1 levels compared to the control group. Interestingly, in this study, the control group also went to the research center once a week for exercise without over-load, warm-ups, or stretching, following the same schedule as the exer-cise group. Thus, the authors were able to conclude that the observed improvements were not attributable to socializing during exercise sessions.

A study carried out by Katula et al.[26]= in 1999 evaluated the relationship between exercise intensity, anxiety, and self-efficacy in healthy older adults. Eighty subjects aged between 60 and 75 years were recruited from another RCT and completed measures of self-efficacy and the STAI (state anxiety inventory [SAI]) before and after light, moderate, and high-intensity PA. Participants had been previously randomized into aerobic outdoor walking or stretching and toning programs. Both groups met three times per week for six months and session times increased gradually from 15 to 40 minutes along the study. The light-intensity sub-group used a standard exercise protocol throughout the six-month time period. Participants self-selected their actual intensity within the prescribed range for heart rate and perceived exertion. The mean age-predicted percentage of heart rate reserve (HRR) in this group was 29%. The moderate-intensity condition included timed completion of the one mile Rockport Fitness Walking Test[31] in the last week of the six-month trial (i.e., participants were instructed to walk one mile on an indoor track as fast as possible). The mean percentage HRR in the moderate-intensity condition was 49%. Finally, the maximal-intensity condition included completing a maximal graded exercise test at the end of the six-month trial (i.e., participants walked at three miles per hour with grade increases of 2% every two minutes on a treadmill). The mean percentage HRR for this group was 96%. State anxiety was significantly reduced by light-intensity PA, not-significantly reduced by moderate-intensity PA, and was significantly increased by maximal-intensity PA. These results contradicted other research on younger adults and were explained by several factors. First, anxiety and arousal were confounded for the impact of the arousal component on the SAI, which increased after maximal-intensity PA. In addition, the researchers noted that the environment may have influenced the anxiety responses because of the moderate and maximal-intensity PAs were completed in an unfamiliar environment that minimized social interaction as compared to the light-intensity condition.

One study by Zhang et al.[27] compared different PA modalities for treating anxiety symptoms in older adults. In this study, 150 older adults (aged between 60 and 70) were divided into five groups, which included swimming, running, square dancing, tai chi, and a control group. Subjects in each group engaged in a moderate-intensity exercise program (i.e., equivalent to 65 and 75% of the maximum HRR], four times per week for 18 months. Participants completed the P300 test, Scale of Elderly Cognitive Function (SECF), Hamilton Depression Rating Scale (HAM-D), and HAM-A scale at baseline 6, 12, and 18 months after the intervention. All intervention groups had significant decreases in HAM-A scores compared to the control group after 12 months of PA. There were no significant differences between the different PA modalities for reducing anxiety symptoms.

The results from this review are summarized in Table 2.

Discussion

Sub-threshold anxiety symptoms are prevalent and commonly unrecognized in older adults. Pharmacotherapy for this age group may have limitations; thus, practicing regular and supervised PA may be an alternative treatment.

As shown in this review, most of the published studies evaluating the effect of PA on anxiety disorders or symptoms have been conducted with young adults. The studies here analyzed showed that PA is effective for improving anxiety symptoms also in older populations. Several plausible physiological mechanisms may explain these results, including neuroendocrine, anti-inflammatory, and

Table 2 Summary of the studies included in the systematic review

Studies	Study design	Assessment scale	Main results
Cassidy et al.[28]	Cross-sectional	BAI	PA was associated with lower BAIscores (OR = 0.5, 95%CI 0.3-0.8).
Bäckman et al.[30]	Cohort	BSI-53	PA protected against future onset of anxiety (OR = 0.9, 95%CI 0.8-1.0).
Antunes et al.[23]	RCT	STAI GDS	Aerobic-trained group showedreduction in anxiety ($p < 0.001$) and depression scores ($p < 0.05$) comparedto controls.
Tsutsumi et al.[24]	RCT	STAI POMS	Strength-trained group presented more improvement in mood and trait anxiety than control group ($p < 0.001$).
Cassilhas et al.[25]	RCT	STAI VAMS	The strength exercise group showed reduction in state and trait anxiety ($p < 0.05$) while control group did notchange significantly; strength-exercise group presented mood improvement ($p < 0.05$) and higher levels of IGF-1($p < 0.05$).
Katula et al.[26]	RCT	STAI	State anxiety was significantly reduced by light-intensity PA, not-significantly reduced by moderate-intensity PA, and was significantly increased by maximal-intensity PA.
Zhang et al.[27]	RCT	HAM-D HAM-A	No differences were found between the different PA modalities for reducing anxiety symptoms.

95%CI = 95% confidence interval; BAI = Beck Anxiety Inventory; BSI-53 = Brief Symptom Inventory-53; GDS = Geriatric Depression Scale; HAM-A = Hamilton Anxiety Rating Scale; HAM-D = Hamilton Depression Rating Scale; IGF-1 = insulin-like growth factor 1; OR = odds ratio; PA= physical activity; POMS = Profile and Mood States; RCT = randomized controlled trial; STAI = State-Trait Anxiety Inventory; VAMS = Visual Analogue Mood Scale.

antioxidant effects of PA. In addition to physiological effects, there are also behavioral, social, and psychological mechanisms involved in symptom amelioration.[16-18]

However, there are insufficient data to determine the best PA modality (i.e., aerobic, resistance, or relaxation and flexibility training) for treating elderly patients, because most studies found no significant differences between modalities.[11-13] Studies with young patients show that moderate to high-intensity PA is superior to low-intensity PA. However, it should be noted that standardized definitions of PA intensity are not available.[12,13] Also, the ideal frequency and duration of PA have not been established.

Two meta-analysis provide interesting information on PA intensity. First, Petruzzello et al.[32] evaluated clinical samples and found that PA duration should be at least 16 weeks. This conclusion is justified by the effect sizes: 0.17 for PA duration of less than 10 weeks, 0.50 for 10 to 15 weeks of PA, and 0.63 for 16 weeks or more of PA. For the frequency of PA, a meta-analysis by Wipfli et al.[33] evaluating clinical samples and healthy adults showed that a PA frequency of three to four times a week was superior to lower or higher PA frequencies.

For older adults, most RCTs have implemented a three times per week program for 12 to 24 weeks,[23-26] but there were no systematic comparisons between different PA frequencies and durations. Two studies compared PA intensities for this age group. Tsutsumi et al.[24] compared low to high intensities for resistance PA and found no significant differences. In contrast, Katula et al.[26] found that light-intensity PA was superior to moderate and intense PA in reducing anxiety symptoms, which contradicted studies with younger patients. However, the authors noted that the lack of a controlled environment for systematically varying PA intensities was a limitation that compromised interpretation of the results (i.e., the environment varied for each of the three intensity conditions). Thus, data are too scarce to draw conclusions on the ideal intensity of resistance and aerobic training for treating anxiety symptoms in older adults.

Although no controlled studies have compared supervised and non-supervised PA for older adults, most authors suggest that PA should be supervised to optimize clinical effects and reduce risks.[11,24,25,28] In contrast to younger adult populations, comparison studies with older patients would be ethically questionable given the higher risks of unsupervised PA in this group.

It is known that meta-analysis studies provide the highest level of scientific evidence. However, a meta-analysis was not possible in the present study due to the methodological heterogeneity among included studies.

In conclusion, although there is insufficient evidence to recommend a detailed PA program as a treatment for anxiety symptoms in older adults, we may infer that PA may be effective to improve anxiety symptoms in this population. This assertion is aligned with the American College of Sports Medicine position stand, which recommends PA for older populations and states that regular PA may minimize the physiological and psychological effects of an otherwise sedentary lifestyle while increasing life expectancies.[34] As people age, they tend to exercise progressively less. Thus, it is important to develop strategies to overcome barriers to PA and stimulate the participation of older individuals in regular PA programs by adapting PA and providing individualized supervision.

Acknowledgements

This study is supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

Disclosure

The authors report no conflicts of interest.

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