

REVIEW

Is exercise an alternative treatment for chronic insomnia?

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The purposes of this systematic/critical review are: 1) to identify studies on the effects of exercise on chronic insomnia and sleep complaints in middle-aged and older adults and to compare the results of exercise with those obtained with hypnotic medications and 2) to discuss potential mechanisms by which exercise could promote sleep in insomniac patients. We identified studies from 1983 through 2011 using MEDLINE, SCOPUS and Web of Science. For systematic analyses, only studies assessing the chronic effects of exercise on sleep in people with sleep complaints or chronic insomnia were considered. We used the following keywords when searching for articles: insomnia, sleep, sleep complaints, exercise and physical activity. For a critical review, studies were selected on the effects of exercise and possible mechanisms that may explain the effects of exercise on insomnia. We identified five studies that met our inclusion criteria for systematic review. Exercise training is effective at decreasing sleep complaints and insomnia. Aerobic exercise has been more extensively studied, and its effects are similar to those observed after hypnotic medication use. Mechanisms are proposed to explain the effects of exercise on insomnia. There is additional documented evidence on the antidepressant and anti-anxiety effects of exercise. Exercise is effective to decrease sleep complaints and to treat chronic insomnia. Exercise presented similar results when compared with hypnotics; however, prospective studies comparing the effects of exercise with medical and non-medical treatments are warranted before including exercise as a first-line treatment for chronic insomnia are necessary.

KEYWORDS: Insomnia; Sleep; Sleep Complaints; Exercise; Physical Activity.

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INTRODUCTION

The prevalence of insomnia in the general population ranges from 10 to 15%, with this condition being more prevalent among women (1). Drug therapy is commonly prescribed for treatment of chronic insomnia; however, sleeping pills have several known side effects when used for long periods of time (2), and prolonged use of benzodiazepines has been associated with mortality (3) and cognitive deficits (4). Recently, new hypnotic drugs have been approved by regulatory agencies for long-term use; however, research studies have not yet examined the effects of these drugs on patients with primary insomnia (5-7).

Given the problems associated with the pharmacologic treatment of insomnia, several non-pharmacologic alternatives have been suggested in the literature. Of these alternatives, cognitive behavioral therapy (CBT) has received the most attention in research (8,9). A review by

Morin et al. (8) concluded that these therapies improve symptoms in 70-80% of patients.

However, non-pharmacologic therapies can result in high maintenance costs because they require frequent monitoring. Exercise training has been proposed as a low-cost, easily accessible and non-pharmacologic treatment alternative (10-12). The purposes of this systematic/critical review are 1) to identify studies on the effects of exercise on chronic insomnia and sleep complaints in middle-aged and older adults and to compare these results with those obtained using hypnotic medications and 2) to discuss potential mechanisms by which exercise could improve sleep in insomniac patients.

METHODS

We identified studies published between 1983 and 2011 using "MEDLINE", "SCOPUS", and "Web of Science". Additional references were gathered from the reference lists of the papers that were found. For the systematic analysis, only studies assessing the chronic effects of exercise on sleep in people with sleep complaints or patients with chronic insomnia were considered. We used the following keywords when searching databases for articles: insomnia, sleep, sleep complaints, exercise, and physical activity. For a

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critical review, studies were selected on the effects of exercise and the mechanisms that may explain the effects of exercise on insomnia.

General association of exercise with sleep

Positive associations between exercise and sleep have been established in the general population (13). Many studies worldwide have demonstrated a significant negative association between insomnia and physical activity (14-23). In a Brazilian study from 2000, data from people aged 25 years or older demonstrated that physically active individuals have fewer complaints of insomnia than sedentary individuals (15). An American study by the National Sleep Foundation called the "sleep in America" poll (14) reported that older respondents (aged 55-84 years) who exercised more frequently had fewer complaints than those exercising <1 time per week. Similarly, a British study found that higher levels of regular physical activity appear to be protective against the incidence of chronic late-life insomnia (16). More recently, a study performed in Greece suggested an association between the level of physical activity and the presence of insomnia in individuals with chronic disease. The results showed that individuals with a moderate-to-high level of physical activity were 56% less likely to have insomnia (18). In Japan, Kim and colleagues (19) investigated adults between 20 and 70+ years of age. Multiple logistic regression analysis revealed an odds ratio (OR) of 1.3, associating insomnia with a reported lack of habitual exercise.

In general, the authors of these studies do not describe what type of physical activity is most prevalent or the intensity and duration of exercise.

EXERCISE INTERVENTIONS

Effects of Acute Exercise

Acute exercise is exercise occurring during only one session (24). When evaluating the effect of acute exercise, the sleep evaluation is frequently performed the same day as the exercise. By evaluating this type of study, we can observe the effects of exercise on sleep.

Several studies have demonstrated positive changes in sleep patterns after acute exercise in good sleepers; however, these studies have been primarily limited to good sleepers with little room for improvement because of ceiling/floor effects (25). Youngstedt et al. (12) performed a meta-analysis and reported an average increase of approximately 9.9 min in total sleep time (TST) and an approximate reduction of 2.1 min in wake after sleep onset (WASO) in good sleepers after acute exercise.

To our knowledge, only one study has evaluated the effects of acute exercise in patients with chronic primary insomnia. The effects of acute exercise are greater in patients with insomnia compared with good sleepers (26), as can be reasonably expected. Three different types of exercise (moderate aerobic exercise - walking; intense aerobic exercise - running; and moderate resistance exercise - weight training) were assessed. Significant results were observed only after moderate aerobic exercise sessions. Polysomnography (PSG) data demonstrated a reduction in the sleep onset latency (SOL - 55%) and total wake time (TWT - 30%) as well as an increase in total sleep time (TST - 18%) and sleep efficiency (SE - 13%). Similar results were observed in the daily log for TST and SOL (26% and 39%,

respectively). In addition, a significant decrease (15%) in pre-sleep anxiety was observed after moderate-intensity aerobic exercise.

Effects of Chronic (Short- and Long-term) Exercise

Chronic exercise is exercise training. When evaluating the effect of chronic exercise, sleep evaluation is not performed on an exercise day. In this sense, the effects on sleep may be continuous (effects experienced on days with and without exercise). Some studies have investigated the effects of short-term or long-term exercise on sleep.

Some clinical studies have attempted to evaluate the effects of long-term exercise on sleep patterns in patients with chronic insomnia or complaints of insomnia. In 1995, Guilleminault et al. (27) conducted the first study focusing on the effects of aerobic exercise in adult patients with chronic psychophysiological insomnia. Moderate aerobic exercise (walking) combined with sleep hygiene therapy was evaluated after four weeks. The results indicated trends toward increases in the TST-sleep diary (mean [SD], from 299 (28) to 324 (34) min), TST-actigraphy (from 328 (43) min to 345 (38) min), in the SOL sleep diary (from 58 (21) min to 47 (32) min), SOL-actigraphy (from 33 (19) min to 26 (20) min), mean number of incidents awakening from sleep incidents, according to a diary (from 3.2 [2.8] to 2.8 [2.7]) and the number of awakening incidents according to actigraphy (from 4.5 [3.2] to 4.0 [3.2]) (27). These results were promising, and many others studies were subsequently performed.

Some researchers have focused on the effects of exercise on sleep in the elderly and older adults with sleep complaints (28-32), often under the assumption that exercise might have the greatest potential to benefit age-related sleep disturbance. These studies primarily assessed subjective sleep, as evaluated by sleep diaries and/or questionnaires.

Studies evaluating residents of nursing homes or assisted living facilities who typically have disrupted sleep reported mixed results. For example, Alessi et al. (28) found no effect of a nine-week exercise program (which involved sit-to-stand repetitions and/or transferring as well as walking or wheelchair propulsion) on sleep, as assessed by actigraphy in nursing home residents. Ferris et al. (29) found improvements compared with baseline in subjective sleep following three months of circuit weight training but not following six months of training. However, exercise has helped reduce fragmentation of the rest-activity rhythm (33) as well as mood disturbances in this population (34).

Older adults with sleep complaints were also evaluated by King et al. (30,31). In their first study, they found a reduction in the total score of the "Pittsburgh Sleep Quality Index (PSQI) (mean [SD], from 8.7 [3.0] to 5.4 [2.8], effect size - ES = -1.1) and self-reported SOL (from 28.4 [20.2] min to 14.6 [13.0] min), ES = -0.68) as well as an increase in reported sleep duration (6.0 [1.1] h to 6.8 [1.2] h, ES = 0.72) following a 16-week moderate-intensity aerobic exercise program. In this study, the associated effect sizes were more impressive when compared with data observed by Guilleminault et al. (27), which were previously described. In another study, King et al. (31) observed that the exercise group reported greater 12-month improvements relative to controls in the PSQI sleep disturbance subscale score (from 1.47 [0.51] to 1.31 [0.47]), sleep diary-based measurement of minutes to fall asleep (from 38.44 [23.32] min to 26.02 [18.5] min), and feeling more rested in the morning (from 3.58

[1.14] to 4.42 [1.52]). Reid et al. (35) evaluated the effects of moderate aerobic exercise in older adults diagnosed with chronic primary insomnia (by DSM-IV). After 16 weeks, the exercise group improved their sleep quality on the global PSQI (mean [SD], from 10.0 [12.3] to 5.0 [6.3]), sleep latency (from 1.6 [1.3] to 1.0 [0.9]), sleep duration (from 2.0 [0.7] to 1.1 [0.7]), daytime dysfunction (from 1.3 [0.5] to 0.5 [0.5]), and sleep efficiency PSQI sub-scores (from 1.2 [1.1] to 0.7 [1.0]) compared with the control group. The exercise group also had reduced depressive symptoms (from 9.5 [18.0] to 2.8 [4.3]) and daytime sleepiness (from 9.2 [14.9] to 5.1 [7.7]) as well as improvements in vitality/quality of life (from 55.0 [21.6] to 80.5 [10.9]) compared with baseline scores. In addition, a reduction in global PSQI scores was associated with a greater reduction in depressive symptoms. After controlling for depression, there was still a significant relationship between the physical activity group and the change in PSQI scores.

Recently, we evaluated the effect of long-term moderate aerobic exercise (6 months) in an open trial on sleep, quality of life, and mood in middle-aged adults with chronic primary insomnia. We also examined whether these effects differed for morning vs. late-afternoon exercise (36). We found no significant differences between times of day in all subjective sleep and polysomnography data. Polysomnography data showed significant reductions in SOL (mean [SE], from 17.1 [2.6] min to 8.7 [1.4] min; $p < 0.01$) and wake time after sleep onset (from 63.2 [12.8] min to 40.1 [6.0] min) as well as a significant increase in sleep efficiency (from 79.8 [3.0]% to 87.2 [1.6]%) following exercise. Sleep diary data revealed significant improvements in SOL (from 76.2 [21.5] min to 80.3 [7.4] min), sleep quality (from 41.5 [5.2]% to 59.4 [6.6]%) and degree of feeling rested in the morning (from 50.8 [5.3] to 65.1 [5.0]). Following exercise, significant increases in some quality of life measures were found, as well as significant reductions in Profile of Mood States (POMS) measures of tension and anxiety (from 7.2 [1.0] to 3.5 [1.0]), depression (from 5.9 [1.2] to 3.3 [1.1]) and total mood disturbance (from 9.2 [4.8] to -1.7 [4.8]). These effects did not vary by time of day. Interestingly, despite the fact that the subjects were not diagnosed as depressed, they experienced reductions in symptoms of depression. In addition, we observed a correlation between improvements in subjective sleep and depression scores even after controlling for depression.

Further studies regarding the effects of aerobic exercise training for patients diagnosed with chronic primary insomnia and for patients in other age groups are needed. In addition, other exercise modalities and intensities should be studied to supplement the evidence regarding the positive effects of exercise for insomniacs.

Resistance exercises (weight training) are among the exercise modalities used in protocols for elderly patients with sleep complaints. Singh et al. (32) evaluated depressed older adults using a 10-week randomized controlled trial. The participants were aged > 60 years with a diagnosis of major or minor depression or dysthymia. The intervention consisted of a supervised weight training program three times per week. The results showed significant improvements in all subjective sleep quality and depression measures. Depression measures were reduced in the intervention group by approximately twice the amount that they were reduced in the control group. Quality-of-life subscales significantly improved in the study group. In a

forward stepwise multiple regression, the percent decrease in depression and the percent increase in strength remained significant predictors of the improvement in total PSQI score.

Another interesting study evaluated the effects of exercise on intra-individual variability in sleep of older adults with sleep complaints (37). After twelve months of exercise training, the authors observed a reduction in night-to-night fluctuations in self-reported time to fall asleep. Based on this result, we can conclude that exercise training improves sleep quality and can also promote a lower variability in initial insomnia, independent of sleep time or sleep wake-up.

RESULTS

We identified 216 studies initially, but only five met our inclusion criteria for systematic review. Two studies investigated older adults with sleep complaints (30,31) and three investigated patients with chronic primary insomnia (27,35,38) (Table 1). We analyzed these studies and found results similar to those observed in a meta-analysis evaluating hypnotic drug use (39).

Exercise vs. Hypnotic Drugs

The effectiveness of drugs on chronic primary insomnia is extensively described in the literature. Smith et al. (39) performed a comparative meta-analysis analyzing studies that evaluated the effects of hypnotic drug use on chronic insomniacs. The authors described reductions of approximately 30% (mean [SD], from 48.8 [29.7] to 34.4 [26.3]) in SOL, approximately 40% (from 3.0 [2.0] to 1.8 [1.4]) in number of awakenings, approximately 47% (from 55.1 [37.8] to 29.5 [19.5]) in WASO, approximately 12% (from 332.1 [55.3] to 372.6 [49.0]) in TST, and approximately 20% (from 3.1 [0.6] to 3.7 [0.9]) in sleep quality rating after chronic hypnotic drug treatment (1-8 weeks).

After long-term exercise (16 weeks - 12 months), older adults with sleep complaints experienced a significant decrease in SOL (mean [SD], from 33.42 [7.1] min to 20.31 [8.1] min, $p = 0.03$) but no significant increase in TST (mean [SD], from 6.76 [1.1] h to 7.19 [0.5] h, $p = 0.46$) after (30,31). The lack of an increase in TST may be due to the participants having an "occupational time" to sleep and wake up. Prospective studies evaluating free time to sleep could better explain these results.

Some studies have investigated the effects of exercise on middle-aged adults with chronic insomnia using PSG, actigraphy or subjective sleep measures (PSQI or sleep diary) (27,35,38). No significant reduction in SOL (mean [SD], from 48.59 [21.3] min to 32.92 [14.0] min, $p = 0.18$) or significant increases in TST (mean [SD], from 5.33 [0.32] h to 6.0 [0.72] h, $p = 0.12$) was found according to subjective sleep data after long-term exercise (4 weeks - 6 months) (27,35,38). Objective data (PSG or actigraphy) demonstrated a significant reduction in SOL (mean [SD], from 25.04 [11.2] min to 17.45 [12.1] min, $p = 0.04$) and significant increase in TST (mean [SD], from 5.53 [0.1] h to 5.84 [0.1] h, $p = 0.05$) after a long-term intervention (27,38). When we compared the results from the subjective and objective data, we observed no significant differences in the percent change (post-treatment - pre-treatment/pre-treatment $\times 100$) in SOL (29.6 [16.3] % and 34.6 [18.9] %, $p = 0.77$, respectively) or

Table 1 - Characteristics of five studies about exercise training for chronic insomnia or sleep complaints.

Type of study and Source	Year	Exercise type	Number of subjects	Duration of intervention	Diagnosis	Outcomes
RCT Guilleminault et al. 1995 (26)	1995	Moderate aerobic exercise (walking) and sleep hygiene therapy	10	4 weeks	Psychophysiological insomnia	↑ TST ↓ SOL ↓ number of awakenings
RCT King et al. 1997 (31)	1997	Moderate aerobic exercise	20	16 weeks	Moderate sleep complaints	↓ PSQI score ↓ SOL-PSQI ↑ sleep duration-PSQI
RCT King et al. 2008 (32)	2008	Moderate aerobic exercise	36	12 weeks	Mild to moderate sleep complaints	↓ PSQI - "sleep disturbance subscale", ↓ PSQI - "sleep diary-based minutes to fall asleep" ↑ PSQI "feeling more rested in the morning"
RCT Reid et al. 2010 (33)	2010	Moderate aerobic exercise	10	16 weeks	Primary insomnia	↑ sleep quality-PSQI ↑ sleep duration-PSQI ↑ ES-PSQI ↓ SOL-PSQI ↓ daytime sleepiness-PSQI. ↓ daytime dysfunction-PSQI ↓ depressive symptoms ↑ vitality/quality of life
RCT Passos et al. 2011 (34)	2011	Moderate aerobic exercise	19	6 months	Primary insomnia	↓ SOL-PSG ↓ WASO-PSG ↑ ES-PSG ↓ SOL-SD ↑ sleep quality-SD ↑ feeling rested in the morning-SD ↓ tension-anxiety ↓ depression ↓ mood disturbance

Abbreviations: RCT- Randomized clinical trial; PSQI- Pittsburgh Sleep Quality Index; PSG- Polysomnography; SE- Sleep efficiency; SOL- Sleep onset latency; TST- Total sleep time; WASO- Wake after sleep onset; SD- sleep diary.

TST (12.4 [7.8] % and 5.5 [0.5] %, $p=0.32$, respectively) evaluated by independent t-tests.

Overall, we observed that improvements after chronic exercise are similar to improvements after hypnotic drug use, as described in Smith et al. (39). However, additional studies comparing the effects of exercise and hypnotic drug use are necessary.

MECHANISMS THAT MAY EXPLAIN THE EFFECTS OF EXERCISE ON INSOMNIA

Acute effects of exercise

Many mechanisms are suggested to explain the effects of acute exercise on sleep in physically active men (10-12). Some of this can explain the effects observed in sedentary patients with chronic primary insomnia performing acute exercise.

Thermogenic Effect

Horne and colleagues (40,41) were the first researchers to suggest the thermogenic effect. They found increases in slow-wave sleep (SWS) following acute exercise in physically active men and explained that these effects could be mediated by thermogenic mechanisms.

Several years later, new evidence suggested that a "trigger" for sleep onset is the decline in body temperature in the evening, which is primarily mediated by increased blood flow to the peripheral skin (42,43). According to this theory, the increase in core temperature caused by exercising

facilitates the initiation of sleep due to the activation of heat dissipation mechanisms controlled by the hypothalamus. Chronic insomnia patients commonly have increased sleep onset latencies. Glotzbach and Heller (44) state that insomniacs have impaired nocturnal temperature down-regulation. In this sense, thermogenic effects may be a plausible mechanism to explain the sleep-promoting effects of chronic exercise on insomnia. However, no experimental studies have investigated the interactions among sleep, exercise and temperature in insomniacs.

Anxiety Reduction

Youngstedt (11) suggested anxiety reduction as a plausible explanation for the effects of exercise on sleep quality in insomniacs. Because anxiety is one of the markers of insomnia, a stimulus capable of reducing it could improve sleep. The anxiety reducing effects of exercise are well established (45). In a recent study, the patients with chronic primary insomnia reduced pre-sleep anxiety after acute moderate-intensity aerobic exercise (26); however, no correlation was observed between reduction in anxiety and improvement in sleep. Further experimental studies are necessary.

Increase in Serotonin

As early as the 1980s, the effects of exercise on circadian sleep-waking rhythms and brain serotonin metabolism in rats were investigated (46). According to Petitjean et al. (47), chronic insomnia may be the result of serotonin activity

deficits. The positive effect of exercise (running) on serum free tryptophan has been described in rats (48). In addition, Chaouloff et al. (49) found that acute exercise (running) increases brain serotonin (5-hydroxytryptamine, 5-HT) synthesis in the following two ways: 1) lipolysis-elicited release of free fatty acids in the blood displaces the binding of the essential amino acid tryptophan to albumin, thereby increasing the concentration of free tryptophan and 2) increased entry of tryptophan into the brain due to an increase in the ratio of circulating free tryptophan to the sum of the concentrations of the amino acids that compete with tryptophan for uptake at the blood-brain barrier. However, this marked increase in central tryptophan levels only slightly increases brain 5-HT synthesis, as assessed by analyzing 5-hydroxyindoleacetic acid levels. This suggests that exercise promotes feedback regulatory mechanisms. Indirect indices of 5-HT function open the possibility that acute exercise-induced increases in 5-HT biosynthesis are associated with (or lead to) increases in 5-HT release. This mechanism appears to be plausible, but experimental studies are necessary.

Chronic effects of exercise

Antidepressant Effects

Antidepressant effects may also explain some of the effects of exercise on insomnia. Insomnia complaints have been viewed as a symptom of depressive illness. In fact, chronic insomnia is a risk factor for depression (50). Several antidepressants have been shown to be associated with a reduction in the amount of rapid eye movement (REM) sleep (51), and one effect of acute exercise is a reduction in REM activity (12).

Singh et al. (32) found reductions in subjective sleep-quality and depression measures in depressed older adults after a 10-week randomized control trial of a supervised weight-training program conducted three times per week.

Evaluating the effects of aerobic exercise on insomnia, Reid and colleagues (35) described the positive effects of a 16-week program in older adults with chronic insomnia. They found a significant correlation between a reduction in global Pittsburgh Sleep Quality Index (PSQI) scores and a reduction in depressive symptoms. After controlling for depression, there was still a significant relationship between the physical activity group and changes in PSQI scores. Recently, we evaluated the effects of a 6-month aerobic exercise program in adults with chronic insomnia. Reductions in POMS depression scores were significantly correlated with improvements in sleep diary measures of sleep quality, SOL, and feeling rested in the morning, as evaluated by PSQI. Moreover, in post-hoc analyses controlling for POMS-depression as a covariate, only the changes in the sleep diary variable of "feeling rested in the morning" remained statistically significant (38).

Recently, an interesting study described depression as a moderator/mediator of improvement in sleep in middle-aged and older adults with sleep complaints (52). The authors observed a decrease in depressive symptoms after a 12-month intervention of moderate aerobic exercise and demonstrated that depression mediated a change in Stage I sleep as evaluated by PSG. Decidedly, the antidepressant effect of exercise is an important factor in improving sleep.

Anxiety reduction

Long-term studies have investigated the effects of exercise on anxiety in patients with sleep complaints. Older adults with a cerebral vascular disorder experienced reductions in anxiety and improved quality of sleep after a long-term intervention with Tai Chi exercise (53). Recently, we investigated the effects of a 6-month moderate aerobic exercise program on sleep in patients with chronic insomnia and found a significant reduction in POMS-tension/anxiety scores as well as improvements in sleep; however, these variables did not correlate (38). Although insomnia is characterized by pre-sleep anxiety (54), the reduction observed after exercise training does not appear to influence sleep improvement directly.

Immunologic Alterations

It is commonly believed that sleep loss resulting from insomnia increases an individual's vulnerability to diseases and that sleep has a key role in illness recovery (55). It has been reported that moderate exercise training can promote immune function (56).

Depressive symptoms, poor sleep quality, and systemic markers of inflammation (e.g., interleukin (IL-6)) are frequently associated (57). Some authors examined individuals with depression to determine if sleep disturbance could predict lowered immune function. They found that increased waking time during the first non-rapid eye movement (NREM) cycle of sleep was negatively correlated with natural killer (NK) cell count (58). A second study in persons with depression demonstrated that self-reported current insomnia is a significant predictor of lower NK cell activity (59). A third study investigated whether clinical insomnia is associated with immune alterations by comparing immune function between patients with chronic insomnia and good sleepers. The authors found significantly higher levels of CD3+, CD4+, and CD8+ cells in good sleepers compared with individuals with insomnia (60). These results are interesting, and while immune function improvement is certainly correlated with sleep, it is not clear whether it is a cause or a consequence. Evaluating the effects of exercise on immunity and sleep in insomnia patients is necessary to clarify this relationship, as immune function may also only be a marker/consequence of sleep disturbance, which may be improved by both exercise and sleep improvement.

OTHER EFFECTS OF EXERCISE ON PATIENTS WITH CHRONIC INSOMNIA

Improvement in Quality of Life

The negative effects of sleep disorders on quality of life are well documented in the literature. The distress and daytime impairment that result from chronic insomnia are directly related to poor quality of life. Furthermore, a recent study described some negative effects of sleep medications on health-related quality of life (physical aspects), possibly because of adverse effects of the medication (61).

Exercise has been suggested as a good alternative therapy to improve quality of life because there is a negative correlation between sedentary lifestyle and quality of life (62). Additionally, some experimental studies have demonstrated improved quality of life after exercise in patients with chronic diseases, including sleep-related diseases, such as sleep apnea (63) and chronic insomnia (35). A recent

study demonstrated that improved quality of life in insomnia patients after moderate aerobic training (16 weeks) quality of life, particularly with respect to vitality scores (35). Similarly, we observed that after long-term aerobic exercise (6 months), there were improvements in quality of life (particularly in the emotional dimension) in patients with chronic primary insomnia (38). Other insomnia therapies have also improved quality of life. Cognitive Behavioral Therapy was tested in breast cancer survivors with insomnia complaints, and positive results were observed after 6 weeks of treatment (64). These results indicate that interventions improving sleep can improve quality of life in insomnia patients. In contrast, some alterations that can be related with improvements in quality of life, such as changes in lifestyle (i.e., increase daily physical activities and social activities), could also mediate improvements in sleep quality.

Exercise is effective to decrease sleep complaints and treat chronic insomnia. Exercise demonstrates comparable effectiveness when compared with hypnotics. However, including exercise in the first-line treatment list for chronic insomnia will require prospective studies comparing the effects of exercise with drug/nondrug treatments.

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AUTHOR CONTRIBUTIONS

All the authors are responsible for the content of the manuscript, having revised and approved its final version. Passos GS, Santana MG and Mello MT had the original idea, selected the studies and wrote the manuscript. Tufik S and Poyares DL selected and supervised the papers.

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