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Effects of exercise on sleep among young women with Generalized Anxiety Disorder

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ABSTRACT

Statement of the problem: Generalized Anxiety Disorder (GAD) and disturbed sleep are prevalent, debilitating, and frequently comorbid problems for which successful treatment remains limited. Exercise can promote sleep but whether it does among GAD patients is unknown.
Methods: Thirty sedentary women (18–37 y) with a primary *DSM-IV* diagnosis of GAD were randomized to six weeks of resistance (RET) or aerobic exercise training (AET), or waitlist (WL). RET and AET involved twice-weekly sessions of either lower-body weightlifting or leg cycling matched on multiple features of exercise. Outcomes included total sleep time (TST), lights out time, awakening out of bed time, time in bed (TIB), sleep onset latency (SOL), wakefulness after sleep onset, and sleep efficiency. Hedges' *d* effect sizes and 95% confidence intervals were calculated for each exercise condition compared to WL. Regression examined baseline associations between anxiety and sleep and associated change.
Results: Twenty-two of 26 participants reported poor baseline sleep (Pittsburgh Sleep Quality Index > 5). RET significantly decreased weekend TIB ($d = -1.79$; [−2.89,−0.70]) and SOL ($d = -1.30$; [−2.32,−0.28]), and significantly increased weekend sleep efficiency ($d = 1.30$; [0.29,2.32]). AET significantly reduced weekend TIB ($d = -1.13$; [−2.16,−0.11]) and SOL ($d = -1.08$; [−2.09,−0.06]). Reduced GAD clinical severity rating was significantly associated with improved weekend sleep efficiency among RET ($t_6 = -3.48$, $p \leq 0.013$).
Conclusions: Short-term exercise training improves sleep outcomes among GAD patients, especially for RET and weekend sleep. Findings suggest improved sleep may be associated with reduced clinical severity among GAD patients.

1. Introduction

Generalized Anxiety Disorder (GAD) and disturbed sleep are prevalent, debilitating, and frequently comorbid public health problems for which successful treatment remains limited. Disturbed sleep may function as an antecedent, concomitant, or consequence of comorbid anxiety disorders (Jansson-Fröjmark & Lindblom, 2008; Johnson, Roth, & Breslau, 2006; Ohayon & Roth, 2003; Ramsawh, Stein, Belik, Jacobi, & Sareen, 2009). Though disturbed sleep is not required for diagnosis of GAD, the *DSM-5* recognizes sleep disturbance as one of six independent, specific symptoms of GAD, and as many as 60% of GAD patients experience disturbed sleep (Papadimitriou, Kerkhofs, Kempenaers, & Mendlewicz, 1988). The available evidence from polysomnographic investigations suggests that GAD patients with mild-to-moderate intensity symptoms frequently experience prolonged sleep latency, lower total sleep time, and poor sleep efficiency (Monti & Monti, 2000; Papadimitriou & Linkowski, 2005). Much of the scant experimental evidence on sleep in GAD has focused on older adults or children and little is known about the sleep of young adults with GAD. Young adults are a population of interest because of their insufficient sleep and irregular sleep–wake patterns (e.g., staying out late on weekends) and because anxiety has been shown to account for most of the variability in their sleep quality (Lund, Reider, Whiting, & Prichard, 2010).

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Pharmacotherapy and behavioral therapy have shown modest efficacy for improving symptom severity and disturbed sleep among GAD patients. For example, ten weeks of co-administered eszopiclone and escitalopram was associated with significant improvements in sleep, daytime functioning, anxiety, and mood among a large sample of patients meeting criteria for GAD and insomnia (Pollack et al., 2008). However, because GAD symptoms are heterogeneous, pharmacotherapy may attenuate one symptom yet exacerbate another. For instance, selective serotonin reuptake inhibitors, such as escitalopram, reduce GAD symptoms but have the capacity to exacerbate sleep disturbances (Schweitzer, 2000). Thus, similarly effective treatments with less risk of side effects (e.g., dizziness, loss of libido) are preferable. The first-line behavioral treatment, cognitive-behavioral therapy, presents significant barriers such as its expense and limited access to trained practitioners. Thus, there is continued interest in learning about inexpensive, alternative therapies for disturbed sleep among young adult patients with GAD.

A low cost and accessible potential therapy for disturbed sleep in GAD may be exercise. The sleep-promoting effects of exercise are well-established (King et al., 2008; Youngstedt, 2005). Evidence from survey and epidemiological research suggests that exercise may be a particularly useful behavior for sleep improvement (Youngstedt & Kline, 2006). Clinical trials of sleep apnea patients have shown significant reductions in apneas and hypopneas independent of reductions in body mass (Iftikhar, Kline, & Youngstedt, 2014; Kline et al., 2011). Reviews of experimental investigations in middle-aged and older adults with sleep problems have shown significant improvements in quality of life and sleep onset latency following exercise training (Yang, Ho, Chen, & Chien, 2012). In addition, reduced anxiety is a plausible mechanism through which exercise may influence sleep (Youngstedt, 2005). However, though exercise improves worry symptoms and the severity of GAD (Herring, Jacob, Suveg, Dishman, & O'Connor, 2012) along with associated signs and symptoms which also may be associated with disturbed sleep, (i.e., symptoms of anxiety, tension, depression, low vigor, fatigue, irritability, and pain) (Herring, Jacob, Suveg, & O'Connor, 2011), the effects of either aerobic or resistance exercise training on sleep among GAD patients are unknown.

Thus, the primary objective of the secondary analyses reported here was to quantify the magnitude of the effect of six weeks of either twice-weekly resistance or aerobic exercise training on self-reported sleep among sedentary young women with a principal diagnosis of GAD. As an exploratory objective we also examined baseline associations between anxiety and sleep and associated changes in response to exercise training.

2. Methods

Detailed methods of the overall randomized controlled trial have been reported elsewhere (Herring et al., 2011, 2012). The trial protocol was approved by the University of Georgia Institutional Review Board. Thirty sedentary women were recruited, agreed to participate, and provided written informed consent. Included women were: (1) 18–37 years of age; (2) engaged in no concurrent psychiatric or psychological therapy other than stable medication use; and (3) had a principal *DSM-IV* diagnosis of GAD. Women were excluded for: (1) too few worry symptoms, defined by both a Psychiatric Diagnostic Screening Questionnaire (Zimmerman & Mattia, 2001) GAD subscale score < 6 and a Penn State Worry Questionnaire (Brown, Antony, & Barlow, 1992) score < 45; (2) a highly physically active lifestyle, defined by a seven-day physical activity recall (7dPAR (Blair et al., 1985)) value >260 kilocalories of energy expenditure per kilogram body weight per week; (3) pregnancy; and/or (4) medical contraindications to moderate-intensity exercise. Diagnostic interviews, including administration of the Anxiety Disorders Interview Schedule (*ADIS-IV* (Brown, Di Nardo, & Barlow, 1994)), were performed by clinicians blinded to treatment allocation. Potential participants assigned a clinician severity rating ≥4 were diagnosed with GAD, and were then enrolled in the intervention within 1–15 days following administration of the *ADIS-IV*. Patients were stratified based on psychotropic medication use (no medication vs. medication use) and randomized to conditions in blocks of three based on the intervention condition (resistance exercise training [RET], aerobic exercise training [AET], and waitlist control [WL]).

2.1. Conditions

Exercise conditions involved two sessions per week for six weeks. Sessions were conducted at approximately the same time of day, approximately 48 h apart on Monday/Wednesday, Tuesday/Thursday, or Wednesday/Friday. Participants were instructed to otherwise maintain their normal lifestyle habits. As reported elsewhere, overall, weekday, and weekend extra-intervention physical activity was assessed with a 7dPAR (Blair et al., 1985; Herring et al., 2012).

2.1.1. Resistance exercise training

The RET condition involved seven sets of 10 repetitions each of leg press, leg curl and leg extension exercises beginning at 50% of predicted one-repetition maximum (1-RM) and progressing by five percent of predicted 1-RM each week (Herring et al., 2012). Each exercise was preceded by a warm-up set of 10 repetitions beginning at 35% of predicted 1-RM the first week and progressing by five percent of predicted 1-RM weekly. Heart rate and ratings of perceived exertion (RPE) were obtained following the completion of each exercise, and a session RPE was obtained following the completion of each workout.

2.1.2. Aerobic exercise training

AET was matched to the RET condition on four features of the exercise stimulus: (1) the time spent actively exercising, (2) the positive work completed during each exercise session, (3) a weekly five percent progression in load (intensity), and (4) a focus on lower-body exercise (Herring et al., 2012). AET involved two weekly sessions of 16 min of continuous, dynamic leg cycling exercise. Heart rate and RPE were obtained during each session at time points that approximated measurement during RET sessions.

2.1.3. Waitlist

Patients randomized to the WL condition delayed entry into any intervention for six weeks, but were tested on all outcomes. Following six weeks, each WL patient was offered a six-week exercise intervention, but no data were obtained during those sessions.

2.2. Sleep data

The Pittsburgh Sleep Quality Index (PSQI) was completed at baseline to help characterize baseline sleep profile and sleep impairment among participants. At baseline and during the final week (week 6) of the intervention, sleep parameters were measured using the Pittsburgh Sleep Diary (PSD) (Monk et al., 1994). Each participant was instructed to complete the PSD daily for seven days. Outcomes of interest encompassed domains of sleep timing (lights out time, awakening out of bed time), duration (total sleep time [TST], time in bed [TIB]), and continuity (sleep onset latency [SOL], wakefulness after sleep onset [WASO], sleep efficiency [calculated as TST divided by TIB and expressed as a