Effects of Trampoline Exercise on Attentional Control and Daytime Sleepiness among Young Adults with Anxiety Disorders in Malaysia

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ABSTRACT

Purpose: *Anxiety disorder has been linked to deficient attentional control and sleep problems in young adults. This study aimed to investigate the possible effects of trampoline exercise on attentional control and daytime sleepiness among young adults with anxiety disorders.*

Method: *This single-blinded randomised controlled trial involved 40 young adults with anxiety disorders. All the participants were initially screened for eligibility using Beck Anxiety Inventory and Physical Activity Readiness Questionnaire, and randomly assigned to either an experimental group (n=20) or a control group (n=20). While the experimental group was subjected to trampoline exercise for 4 weeks, all the participants in both the groups were taught deep breathing exercise. Attentional control and daytime sleepiness of the participants were evaluated using Attentional Control Scale and Epworth Sleepiness Scale respectively.*

Results: *The experimental group showed statistically significant improvement in Attentional Control Scale (p=0.009) and Epworth Sleepiness Scale (p=0.005) compared to the control group.*

Conclusion: *Trampoline training resulted in reduction in daytime sleepiness and improvement in attentional control after 4 weeks of trial. This highlights the potential of trampoline exercise training as an adjunct to established clinical treatment.*

Key words: *Trampoline, sleep quality, cognitive, exercise, rebound, anxiety disorders.*

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INTRODUCTION

Anxiety disorders are neurotic disorders that are characterised by excessive or uncontrolled worry, negative feelings about the future, or distress that triggers a sense of defensiveness so that the individual can prepare to face a possibly dangerous situation. Anxiety can be a debilitative emotion that can adversely affect performance. Adolescence and young adulthood are periods of critical development and transition, and the onset of symptoms of anxiety in young people are sometimes overlooked as being part of this transition phase. At this time, young people undergo major physical, cognitive, and psychosocial changes, and can be very susceptible to the development of anxiety disorders (Paus et al, 2008). Studies have shown a prevalence of anxiety disorders of 5 - 19% among young people (Pine, 2008).

Prevalence of mental health conditions in late adolescence and early adulthood has increased over the past few decades. People with high anxiety frequently report that they find it difficult to concentrate on tasks that need undivided attention and are easily distracted. It is common for individuals with high levels of anxiety to worry excessively about a variety of issues, ranging from their performance in upcoming examinations, job interviews, attending meetings and giving talks, to multi-tasking and managing everyday activities efficiently. All these are of paramount importance in the life of young adults. Earlier studies by researchers have suggested that anxiety impairs performance via its adverse effects on a central mechanism which is attentional control (Eysenck et al, 2007; Derakshan & Eysenck, 2009). Every 3 in 10 adults in Malaysia, aged 16 years and above, have some sort of mental health problems (29.2%) (National Health and Morbidity Survey, 2015). Moreover, a cross-sectional study conducted among four public universities in Klang Valley found that anxiety had a higher prevalence among university students compared to depression and stress (Shamsuddin et al, 2013).

Attentional control is an important function of the working memory, a system that regulates incoming information and helps with temporary storage of information. Thus attentional control is vital as it helps the individual to be cognitively flexible, to concentrate on tasks and to resist distracting thoughts and information when necessary. There is now substantial evidence to support the prediction that anxiety impairs performance via its impact on attentional control (Berggren et al, 2013). Growing evidence suggests that symptoms of anxiety and depression have robust relationships with deficit in attentional control (Sportel et al, 2011).

Sleep and exercise influence each other through complex, bilateral interactions that involve multiple physiological and psychological pathways. Physical activity is usually considered as beneficial in aiding sleep, although this link may be subject to multiple moderating factors such as sex, age, fitness level, sleep quality and the characteristics of the exercise (intensity, duration, time of day, environment). It is therefore vital to have a better understanding of the benefits of exercise on the quantity and quality of sleep in healthy subjects and clients. According to the International Classification of Sleep Disorders, Excessive Daytime Sleepiness (EDS) is defined as difficulty in maintaining the alert awake state, usually accompanied by a rapid descent into sleep when the person is sedentary. EDS is characterised by lack of energy, fatigue and tiredness, and of feeling sleepy and drowsier than usual in the daytime. A study that had investigated sleep behaviour among university students in Malaysia, determined that 30.6% of the students had suffered EDS and generally had poor sleep quality (Lai & Say, 2013).

Exercise is said to have an anxiolytic effect as a result of several changes in physiological and psychological mechanisms that impact the pathophysiological process of anxiety. Research on the acute effects of exercise on cognitive performance has shown that it can positively influence cognition in adults (Lambourne, 2010). However, the effects differ according to the characteristics of the exercise intervention (i.e., intensity, duration, and type) and the cognitive test utilised. Interestingly, physical exercise has recently been suggested as a factor that enhances attention. It provides an outlet for frustrations and releases mood-enhancing endorphins. Exercise had been said to induce positive changes in the regulation of HPA axis which leads to modulation of stress reactivity and anxiety. Chen et al (2014) conducted a study to examine the effect of exercise on the HPA axis in animals and found that exercise was effective in reducing anxiety symptoms by regulating the baseline ACTH and adrenaline level in response to stress.

In this regard, trampoline training is a popular activity for young adults, with the added benefit being the avoidance of monotonous physical exercise. In general it improves strength, stamina, cardiorespiratory fitness, balance and coordination and also aids in boosting confidence and social skills. Trampoline exercise is good for boosting the immune system and detoxification because it can increase lymphatic drainage by 15 - 30 times compared to jogging or running (Axe, 2017). It is believed that trampoline exercise can induce relaxation and release stress and anxiety (Carter, 2017). Exercises on trampoline had portrayed a similar relaxing effect to that of hydrotherapy and horse-riding therapy (Miller, 2007). Due to the neuronal structures responsible for coordination as well as cognition, the authors of the current study hypothesised that trampoline exercise would lead to a general pre-activation of cognitive-related neuronal networks and would be more effective in improving attentional control.

Objective

Little evidence is available on trampoline exercise as an intervention in anxiety disorders, and no literature was found on studies with specific focus on attentional control and sleep quality. Therefore, the aim of this study was to determine the effects of trampoline exercise on attentional control and daytime sleepiness among young adults with anxiety disorders.

Ethical Considerations

Ethical approval was obtained for this study from Scientific and Ethical Review Committee (SERC) of Universiti Tunku Abdul Rahman (UTAR). Written informed consent was obtained from all participants before the trial.

METHODS

Study Design

A single-blinded randomised controlled trial design was adopted to determine the effects of trampoline training.

Study Sample

Participants were identified by purposive sampling. Beck Anxiety Inventory (BAI) and Physical Activity Readiness Questionnaire (PAR-Q) were distributed randomly among students of Sungai Long campus of UTAR, Malaysia, to screen and recruit young adults with anxiety symptoms for the trial. The BAI (Fydrich et al, 1992) and PAR-Q (Shephard, 1988) had shown high reliability and validity. Based on inclusion and exclusion criteria, 40 participants were recruited and allotted to either a control group or an experimental group.

Inclusion criteria:

- Persons of either gender between the age of 18 and 25.
- Those with BAI Score ≥10 i.e.; those with mild to severe anxiety level.

Exclusion criteria:

- Those with history of neurological disease, psychiatric illness, hypothyroidism, head injury, diabetes, stroke, hypertension, substance abuse, smoking, or any difficulty that could interfere with behavioural and cognitive testing.
- Those who were on medications like tranquilizers, sleeping pills and antihistamines.
- Those with spinal problems, hypermobile/unstable/painful joints were also excluded.

All the 40 participants were assessed prior to and at the end of 4 weeks of trampoline training.

Outcome Measurements

Levels of daytime sleepiness and attentional control of participants were assessed using Epworth Sleepiness Scale and Attentional Control Scale respectively. The Epworth Sleepiness Scale (ESS) is an 8-item measure that assesses the likelihood that the individual will fall asleep during different situations. This is a simple, self-administered questionnaire which is shown to provide a measurement of the subject's general level of daytime sleepiness (Johns, 1994). The Attentional Control Scale (ACS) is a questionnaire that has been developed to measure individual differences in attentional control. The Attentional Control Scale is a 20-item self-report measure assessing attentional focusing and shifting (Judah, 2014). Both outcome measurements were measured at baseline and after 4 weeks, for all participants.

Exercise Procedure

Baseline treatment: Participants had been put into the intervention group and the control group using block randomisation. This was to ensure that roughly equal numbers of participants were randomly assigned to the two groups in such a way that both known and unknown prognostic factors were balanced at the start of the trial. Randomisation was performed using computer-generated random numbers (Research Randomiser). Deep breathing exercises as a baseline treatment was given to both groups. They were asked to take 6-8 breaths per minute, for 10 minutes per day, for 4 weeks. The exercise was taught individually at the Physiotherapy centre of UTAR, Sungai Long Campus, Malaysia.

Trampoline exercise programme: Trampolines of 121 cm width and 25 cm height, with safety pads that covered the entire steel frame and rubber tipped legs, were used. Safety measures involved checking the trampoline regularly for tears, rust, and detachment. The participants were required to wear appropriate sports attire and to remove all earrings, pierced or otherwise, along with any other jewellery. The exercise protocol included a standardised warm-up exercise programme. Participants were asked to stand on the trampoline with feet shoulder-width apart, relax shoulders and arms but slightly bend both elbows, and lightly bounce up and down on the trampoline with knees slightly bent. The workout consisted of six movements: double leg push down, double leg in and out, alternating heel-toe, jumping jacks, alternating high knee lift, and wide base sprint on the spot. They were required to complete three sets with 1 minute active rest in between sets, and 30 repetitions for each movement. The exercise training programme was demonstrated and explained to each participant. The cooling-down exercise consisted of self-stretching exercise for lower body muscles; each stretch to be held for 20 seconds, for 5 repetitions.

Statistical Analyses

Data on daytime sleepiness and attentional control of both groups was statistically analysed using Statistical Package for the Social Sciences (SPSS) version 22, to compare the effects of trampoline exercise. Chi-square test and t-test were used to compare both groups. Paired t-test was used to compare pre- mean daytime sleepiness and attentional control scores, and post- mean daytime sleepiness and attentional control scores between the experimental group and control group.

RESULTS

The study sample consisted of 40 young adults with anxiety disorders. Male to female ratio of participants was 1:4 in both the groups and the mean age was 20.22 years.

Table 1 shows the age and gender characteristics of the participants in both experimental and control groups; there were no significant differences between both groups in terms of gender and age when the p values were 0.75 and 0.66 respectively. Participants in both the experimental and control groups showed no significant differences in terms of gender and age, ensuring homogeneity between the groups.

Table 1: Characteristics of the Participants in Experimental and Control groups

		Experimental Group n (%) / mean (sd)	Control Group n (%) / mean (sd)	P
Gender[A]				
	Male	5 (55.6%)	4 (44.4%)	0.705
	Female	15 (48.4%)	16 (51.6)	
Age[B] **(years)**		20.30 (0.979)	20.15 (1.182)	0.665

The mean BAI score was 21.41±9.39. It was found that 48.7% of the participants exhibited mild to moderate anxiety levels, 38.5% exhibited moderate to severe anxiety, and 12.8% exhibited severe anxiety.

The experimental group was subjected to trampoline training and had better sleep quality and attentional control compared to the control group.

Table 2 shows the results of ESS and ACS in the experimental and control groups. In the experimental group, pre-test and post-test values of ESS score showed a mean difference of 2.75 (p=0.005). Pre-test post-test values of ACS in experimental group showed a mean difference of 4.45 (p=0.009). The control group demonstrated better attentional control but there was no statistically significant difference (p=0.51). In the control group, pre-test and post-test values of ESS score showed a mean difference of 1.90 (p=0.004).

Table 2: The Final Results of ACS and ESS in pre- and post- tests for both Experimental and Control groups

	Experimental Group	Control Group
ACS Pre	48.05 (7.23)	50.45 (7.31)
ACS Post	52.50 (6.66)	51.30 (6.34)
$t^{\$}$	-2.890	-0.672
p	0.009*	0.51
ESS Pre	9.90 (4.71)	10.50 (3.39)
ESS Post	7.15 (4.80)	8.60 (3.50)
$t^{\$}$	3.138	3.329
p	0.005*	0.004*

DISCUSSION

Due to the neuronal connection between the cerebellum and the frontal cortex, the researchers hypothesised that cognitive performance might be influenced by bilateral coordinative exercise, and that its effect on cognition might already be visible after short bouts of exercise. Compelling support for the view that acute aerobic exercise can facilitate cognitive functioning is provided by empirical data on adults (Tomporowski, 2003). Trampoline exercise is considered as a useful co-ordination exercise. A jumping exercise on trampoline was found as useful co-ordination training among youngsters in a study conducted at National University of Physical Education and Sport of Ukraine (Boloban et al, 2016). Accordingly, findings by Hillman et al (2008) imply that acute bouts of cardiovascular exercise may enhance the allocation of attentional and memory resources, and hence benefit executive control function in undergraduates. Another study with adolescents tested the relationship between motor coordinative abilities and cognition, and showed positive and significant associations between the latent motor and cognitive variables. Trampoline exercise demands the ability to balance, to react, to adjust and to differentiate. Coordinative exercise is known to involve an activation of the cerebellum which, besides motor functions, influences a variety of neurobehavioural systems including attention (O'Halloran, 2012). The results of another study conducted among young adults suggest that moderate aerobic exercise modulates the functioning of phasic alertness by increasing the general state of tonic vigilance (Florentino et al, 2011). In addition to an activation of neural parts of the brain like the frontal lobes (Hernandez, 2002), coordinative exercise is supposed to lead to an excitation of the cerebellum (Diedrichsen et al, 2007) which is also responsible for mediating cognitive functions. A study by Buddea et al (2008) suggested that coordinative exercise leads to a facilitation of neuronal networks, resulting in a general preactivation of consequent cortical activities responsible for cognitive functions like attention.

The brain, like muscles and other organs in the body, responds positively to exercise. Physical activity - of moderate to vigorous intensity - increases neurogenesis in the hippocampus; this increases BDNF (brain derived neurotrophic factor), a protein that causes neurons to fire more effectively. This combination gets oxygen and glucose faster to the brain, increases mood and elevates a person's stress threshold. Essentially, exercise creates a brain superhighway that can happen at all ages and stages in life (Mohr, 2016). Exercise increases GABA (Gamma-Amino Butyric Acid), which acts like a neurotransmitter to help the brain focus and feel calm. On the basis of human brain imaging and animal studies showing that neuronal structures like the cerebellum and the frontal lobe are responsible for coordination as well as cognition (Serrien et al, 2006), it was hypothesised that coordinative exercise would be more effective than the control condition in improving the speed and accuracy of the following concentration and attention tasks. Picard and Strick (1996) specified that motor complexity covaries with the pattern of brain activation, and thus with the degree of information processing. The higher the motor demand, the more prefrontal cortex activity is required during the execution of motor tasks. Exercises emphasised in the trampoline exercise group require a higher variety of frontal-dependent cognitive processes. The findings of a recent study showed that improving attentional control can reduce anxiety in individuals with an anxious predisposition (Course-Choi et al, 2017). Researchers found that exercise primarily helps the brain's ability to ignore distractions, although they are not sure of the exact reasons (Collins, 2015).

The findings of the current study are in accord with a study by Reid et al (2010) that stated moderate aerobic exercise had improved sleep significantly and across several measures of sleep, including sleep duration and sleep quality, as well as daytime sleepiness. Although gender imbalance may affect the generalisability of the study, the findings remain relevant to people with sleep problems because sleep problems are more prevalent among women than men (Ohayon, 2002). A review on the effects of physical exercise in reducing excessive daytime sleepiness suggested that the protective effect of exercise may be partially attributed to the anti-inflammatory effect of regular exercise (Eda et al, 2013). Researchers found that reductions in two biomarkers, BDNF and IL-1β, are related to reductions in hypersomnia after exercise (Rethorst et al, 2015).

The findings of the current study showed that EDS scores improved in the control group that was subjected to breathing exercise. Effective breathing techniques elevate the head and chest to maintain the airway patency. Breathing correctly means that bodies are supplied with the right amount of oxygen, and the brain and other vital organs are replenished with essential nutrients. Slow, deep breathing actually helps the body override the sympathetic system which controls the fight-or-flight response, and lets the parasympathetic system control the ability to relax (Pramanik et al, 2010). Another study by Chien et al (2015), conducted among clients with major depression, reported that cognitive behavioural intervention combined with a breathing relaxation exercise improved their sleep quality and heart rate variability. Though statistically not significant, there was marginal increment in attentional control in the control group. Earlier studies have observed attention impairment related to breathing dysfunction in dementia and sleep-disordered breathing in individuals across all ages (Chervin et al, 2006). More recent studies have suggested that there is a bidirectional association between breathing and attention. Three months of intensive focussed attention meditation has been found to reduce variability in attentional processing of target tones and to enhance attentional task performance (Lutz et al, 2009). On long-term use, breathing exercise may represent a non-pharmacological approach for improving specific aspects of attention.

Exercise improves sleepiness by affecting mood. Additionally, exercise improves metabolic factors, such as visceral fat and insulin resistance (Wannamethee et al, 2000), that have been shown to be independently associated with excessive daytime sleepiness (Vgontzas et al, 2001). Lack of regular exercise and depression were significant predictors of daytime sleepiness (Basta et al, 2008). The expectation that exercise will benefit sleep can partly be attributed to traditional hypotheses that sleep serves energy conservation, body restoration or thermoregulatory functions, all of which have guided much of the research in this field. Exercise is a complex activity that can be beneficial to general well-being. It offers a potentially attractive alternative or adjuvant treatment for sleep problems. Whereas sleeping pills have a number of adverse side effects and are not recommended for long-term use, partly on the basis of a significant epidemiologic association of chronic hypnotic use with mortality, exercise could be a healthy, safe, inexpensive, and simple means of improving sleep. From a clinical standpoint, the findings of this study suggest that trampoline exercise should be part of the comprehensive management of persons with anxiety disorders suffering from excessive daytime sleepiness and lack of attentional control.

CONCLUSION

The most important message from this research is that attentional control and sleep quality can be improved within a comparatively short span of 4 weeks of training with trampoline exercise. The implications of improving attentional control and reducing daytime sleepiness are enormous in education and clinical science. It may also protect against the development of clinical anxiety which can be debilitative to the individual. Trampoline training is an efficacious and cost-effective adjunct to established clinical treatment to improve mental health and alleviate the lives of young adults who suffer from anxiety disorders. One important direction for future work would be to examine the effects of exercise within a multi-factorial framework in which various factors of cognition can be measured or manipulated. Future studies should aim to verify how other neuropsychological tasks measuring different cognitive abilities are affected by long sessions of trampoline exercise in differently active groups.

Implications and Limitations

The findings of this study are of clinical importance because the demonstration of the feasibility of an exercise programme to improve sleep quality in young adults with anxiety, together with the positive effects on cognitive health, underscores the importance of incorporating trampoline exercise in any comprehensive programme for the management of anxiety in young adults. Nevertheless certain limitations, such as the relatively small size of the study sample and the preponderance of female participants, might have impacted upon the reliability of the findings and the generalisability of results. Along with subjective measures, objective measures could have been employed to assess effectiveness. Therefore, further studies with larger samples and using objective measures are recommended.

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