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Effect of Acute Moderate Intensity Aerobic Exercise on Attributes of Sleep Among Insomniac University Students: A Pilot Study

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ABSTRACT

Background: A student life is full of challenges and opportunities. Academic stress, the use of modern-day gadgets such as smartphones and tablets, the modern lifestyle, and many other contributing factors can lead to difficulty in sleeping. Poor sleep has been associated with a lack of focus, concentration, psychological and psychosomatic issues. The impact of exercise on various sleep disorders and sleep attributes among a university student population is relatively limited. This study aims to investigate the effect of acute moderate-intensity aerobic exercise (AMIAE) on insomnia and daytime sleepiness among insomniac university students.

Methods: 31 (67% females, 32.3% males) healthy sedentary undergraduate university students suffering from insomnia symptoms (Athens' insomnia score) have participated in the study. A single bout of moderate intensity aerobic exercise with a duration of 30 minutes, excluding warm up and cool down, given at the intensity (determined by 40% to <60% of Target Heart Rate (THR)) on a treadmill has been used as an intervention strategy. Pre and post-scores of the Athens Insomnia Scale (AIS) and daytime sleepiness using the Epworth Sleepiness Scale (ESS) were measured before and after the exercise intervention.

Results: Paired sample t-test has shown a significant reduction ($p < 0.001$) in the mean score of the Athens Insomnia Scale (AIS) from 8.74+/-2.54 before the exercise intervention to 5.55+/-4.27 after the exercise session. The Epworth Sleepiness Scale (ESS) also showed a significant decrease ($p < 0.001$) in mean score, from 8.52 ± 3.99 to 6.23 ± 4.30.

Conclusion: This study demonstrates that acute moderate-intensity aerobic exercise (AMIAE) can enhance sleep among university students. These findings can serve as a reference and also motivate us to explore the role of exercise and physiotherapy techniques in the field of sleep medicine. Students are considered the future of tomorrow, and the inculcation of appropriate exercises guided by a physiotherapist at the grassroots level (including schools and higher education) is essential. It may help them to have sound sleep and stay healthy, which can have a substantial positive impact.

Keywords: Moderate intensity exercise, aerobic exercise, attributes of sleep, insomniac university students, Parasympathetic Nervous System (PNS)

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INTRODUCTION

Insomnia can be defined as a widespread clinical complaint characterized by difficulty initiating or maintaining sleep, and is associated with subsequent daytime symptoms, such as irritability or tiredness during wakefulness [1, 2, 3]. It can also be associated with frequent nocturnal awakenings, prolonged intervals of wakefulness during sleep, or recurrent transient arousals [4].

Insomnia is frequently classified by the duration of the sleep issues, for example: transient insomnia – lasting less than a month, short-term insomnia – lasting between one and six months, and chronic insomnia – lasting more than six months. At the same time, it can also be categorized as: primary insomnia, which appears without any other co-existing disease. Next to it is the co-morbid insomnia, which can be observed when insomnia occurs in combination with another medical or psychiatric illness. It does not have to be due to or change with the co-existing disorder [5]. Insomnia can also be classified as acute, intermittent, or chronic [6]. As a presenting symptom, insomnia can also be associated with several common sleep disorders, but it also often occurs as a coexisting condition with mental and bodily health conditions [6]. According to the DSM-V, primary insomnia is now referred as insomnia disorder. It can be diagnosed just in the absence of suffering from any concurrent medical and mental illness [7, 8].

Insomnia can lead to or be associated with difficulties in performing daytime tasks, as well as reduced efficiency in academic or workplace settings, tiredness or exhaustion, recurrent daytime sleepiness, and increased risk of making mistakes in work or personal tasks. Furthermore, it may increase the chances of an accident, poor memory, emotional instability, or petulance, reduced social skills, and a general feeling of a meager quality of life, as well as trouble staying focused or attentive. It may lead to mediocre academic performance [9, 10, 11]. Even a single night of lack of sleep can impact day-to-day functioning. The execution of various psychomotor functions, such as vigilance, reaction time, and divided attention, has been shown to decline with sleep fragmentation and sleep deprivation. Psychiatric illnesses such as depression are often found as a comorbidity and are frequently observed among the insomniacs [12]. Additionally, after a single night of sleep deprivation, positron emission tomography (PET) studies have also shown that amyloid-beta protein (Aβ) accumulates in people with healthy brains, which supports the idea that the glymphatic pathway may be active during sleep in humans [13].

In a review article, Mehta et al. (2022) suggested that sleep and mood influence cognitive functions, thereby also affect academic performance [14]. The complex interplay between sleep and cognition demonstrates that consistent, stable sleep of at least 7 hours per night improves working memory and response inhibition in healthy adults. (Zimmerman et al., 2024) [15]. In a review, Spiegelhalter et al. (2010) concluded that, along with many other attributes, properly defining the insomnia diagnosis is essential. On the other hand, findings lead to the conclusion that insomnia is related to an amplified danger of cardiovascular disease, mediated by high blood pressure or a higher resting heart rate. Therefore, further attempts should be made to address the increasing prevalence of people with insomnia in public [16].

In a cross-sectional survey, Zailinawati et al. (2012 stated that insomnia is a widespread public health issue, with a projected prevalence among both the Western and Asian general populations in the range of 11-50% [17]. Additionally, in a systematic review and meta-analysis, Gardani et al. (2022) observed moderate effects for associations between factors such as sleep quality, insomnia, and stress among undergraduate students [18]. In an unpublished study, 'Knowledge, Awareness and Prevalence of Insomnia Among Physiotherapy Students,' based on a self-made and validated questionnaire, among 208 physiotherapy students with a response rate of 95% (Tarun and researchers, 2016), found that 50% of the participants were insomniacs [19]. A study conducted by Lai and Say (2013) among students from the UTAR Kampar campus in Malaysia has shown poor sleeping habits and behaviour. Based on the PSQI, a total of 8.7% of students reported having perfect overall sleep, 58% reported having good sleep, and 33.3% reported having relatively insufficient or terrible sleep [20].

In a systematic review and network meta-analysis of randomized controlled trials, Bahalayothin et al. (2025) concluded that exercises that cause muscle strengthening, rather than aerobic exercises or a combination of exercises, are the most efficient method for improving sleep quality [21]. To decrease bias and variation in the intensity and duration of the exercises, they also suggested using objective outcome measures and smartwatch trackers [21].

Furthermore, a systematic review by Alnawwar (2023) has also concluded that regular physical activity may lead to a reduction in sleep latency and an overall improvement in sleep quality. It has also been suggested that regular moderate-intensity physical activity is the most effective. Although suggestions were made to avoid high-intensity exercises in the evening or close to bedtime. There is also a need to establish an ideal exercise regimen, including the duration and regularity of exercise. Lastly, there is also a need to understand the underlying mechanisms [22]. Yamanaka et al. (2015) suggested that morning exercise enhances the quality of nighttime sleep by increasing parasympathetic nerve activity. In contrast, evening exercise can surge sympathetic activity, which in turn affects sleep quality [23]. Exercises have been used as an interventional strategy for improving sleep quality, and their effectiveness needs further corroboration among the student population. In a systematic review, Wang and Boros (2019) discussed how moderate exercise has shown more promising results and improvements in sleep quality compared to vigorous exercise. Furthermore, Wang & Boros (2019) also suggested that future research should explore detailed exercise suggestions for various

age groups, allowing for precise references to be made for health promotion [24].

MATERIALS AND METHODOLOGY

An experimental pilot study was employed for this investigation. Participants with inclusion criteria were characterised by participants who were non-smoker, full-time undergraduate physiotherapy students, with a total score > 6 on Athens Insomnia Scale (AIS), having a sedentary lifestyle (screened by International Physical Activity Questionnaire (IPAQ)), should be healthy and devoid of any history or currently suffering with cardiovascular and pulmonary disorder (screened by Physical Activity Readiness Questionnaire (PAR-Q)). On the other hand, those who were under any medication that may influence sleep, with a history of cardiopulmonary issues, and were on medication, performing or involved in other moderate and vigorous exercises/activities were excluded from the study.

Sample size calculation: The Snowball sampling method was used to identify the potential participants.

Recruitment of samples: A total of 31 students pursuing a Bachelor of Physiotherapy (Honours) have participated in the study.

Compensation: Participants received no monetary or other benefits, and their participation was entirely voluntary.

Screening: The scores obtained for the Epworth and Athens insomnia scales were used in the screening session and also served as a pre-test score for the study.

Physical Assessment: A comprehensive physical checkup, including a fitness level assessment and sleep evaluation, was conducted before selecting and proceeding with the actual study. The following questionnaires and scales were used for assessment.

Physical Activity Readiness Questionnaire (PAR-Q) has been used to assess the fitness level (current cardiovascular and pulmonary fitness level of the individual) before any exercise prescription is given [25].

International Physical Activity Questionnaire (IPAQ): A scale used to identify the activities of daily living, such as sedentary or active. The reliability and validity of the questionnaire have been proved in different countries (Craig CL et al., 2003) [26].

Athens Insomnia Scale (AIS): The AIS is used to assess insomnia symptoms and their severity. Internal consistency 0.84 (95% CI: 0.81-0.86) and retest reliability of 0.86 (95% CI: 0.80-0.92). (Haitham Jahrami et al., 2023, Kawaratani et al., 2022) [27,28].

The Epworth Sleepiness Scale (ESS) is a scale that assesses daytime sleepiness, with a Cronbach's alpha of 0.73 to 0.86 (Kendzerska et al., 2014) [29], which has been used to identify participants with high values, indicating incidences of daytime sleepiness.

The following instruments have been used to identify and assess the outcome of the findings.

Treadmill (Techno Series 8800D-AC) ("Commercial Treadmill | manufacturer supplier from Taiwan wholesaler distributor-fitnessequipmentsupplier.com", 2017) has been used to perform the exercises [30].

Pulse Oximeter: Pulse Oximeter (PR) (Finger Pulse Oximeter / Finger Oxygen Meter with Pulse Rate Monitor: (Best Price in Malaysia, 2017), was used to monitor the heart rate and oxygen saturation of (SPO2) level of participants throughout the exercise session and it was ensured that heart rate of participants was kept within the range. The reliability and validity of the peripheral pulse oximeter have been established in previous studies, with an intraclass correlation coefficient (ICC) of more than 0.93 (Losa-Iglesias et al., 2014) [31].

Digital Sphygmomanometer (Omron M2 sphygmomanometer – GLOSAWEL, 2017): On the experimental day, systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) of participants were monitored and recorded before and after the exercise session using a digital sphygmomanometer. The validity of the Omron sphygmomanometer has been proved (Asmar et al., 2010) [32].

Ethical and Human Issues: Ethical clearance was obtained from the Institute of Postgraduate Studies and Research (IPSR) at Universiti Tunku Abdul Rahman (UTAR), Malaysia.

A clear explanation of the potential risks, benefits, and purpose and objectives of the study was given to the participants.

Participants were instructed to report any chest pain, severe shortness of breath, vertigo, balance issues, and confusion during the exercise session. Furthermore, they were being informed to report any uncomfortable feeling in their chest, unable to speak comfortably with severe fatigue, wheezing, or leg cramps, immediately. Participants were requested to refrain from participating in any recreational sports, consuming extra caffeinated products, and drinking energized drinks on the experiment day. They were allowed to carry out their daily routines.

Controlling for potential confounding variables: Sincere efforts were made to ensure and control for confounding variables, including the use of the same instruments and environmental conditions, such as temperature, as well as the timing of exercise sessions (from 11:00 a.m. to 3:00 p.m.). Exercises were scheduled on weekdays. They were instructed to refrain from participating in other moderate and vigorous activities. Participants were suggested and requested to wear sports attire and sports shoes during the exercise session.

Pre-test Assessment:

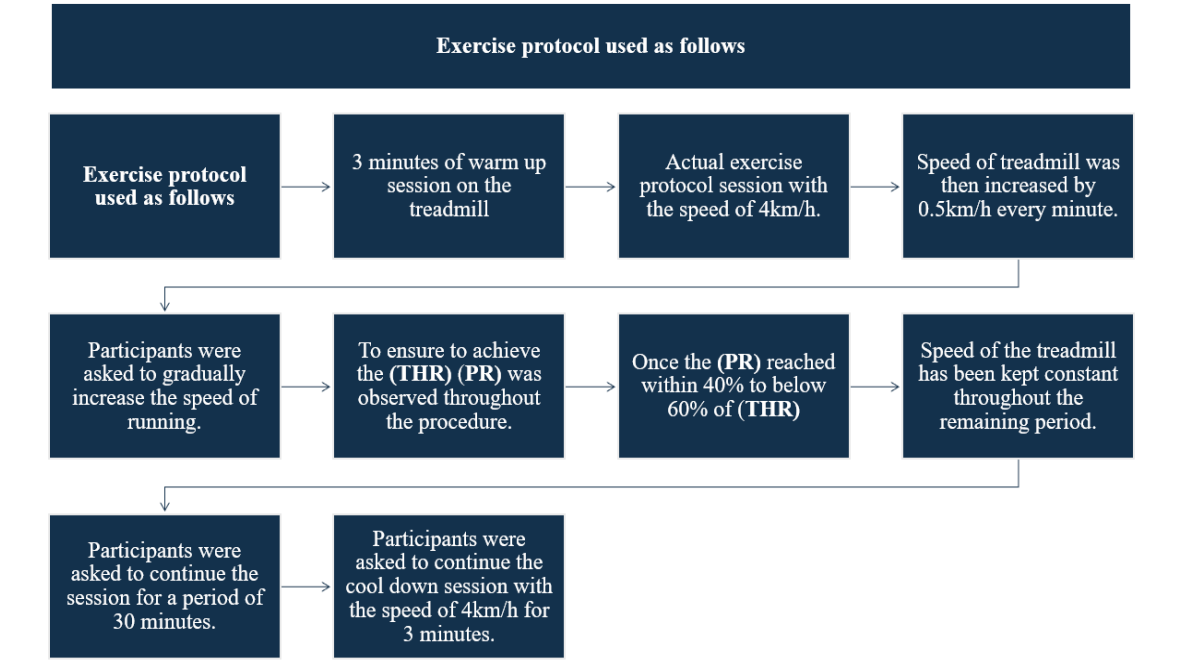
After explaining the aims and objectives of the study, informed consent was obtained prior to the commencement of the exercise session. Demographic data, including name, gender, and age, has also been collected. The target heart rate (THR) for each subject was calculated using Karvonen's formula. The Maximum Heart Rate (MHR) of the students

was calculated by subtracting the age from 220. Maximum Heart Rate (MHR) = 220 – age, where the resting heart rate obtained and was subtracted from the maximum heart rate to obtain the heart rate reserve. Heart Rate Reserve (HRR) = Maximum Heart Rate (MHR) – Resting Heart Rate (RHR). The moderate exercise intensity for the samples was calculated using the formula below, which ranged from 40% to < 60% of the Target Heart Rate. The target heart rate was obtained by adding the resting heart rate to the product of the heart rate reserve and exercise intensity.

THR = (HRR x Exercise intensity) + RHR

Exercise Protocol: Several aspects of the exercise protocol were adapted and modified from a study conducted by Passos et al. (2010) [33], which examined the effects of moderate-intensity aerobic exercise, high-intensity aerobic exercise, and moderate-intensity resistance exercise on sleep in patients with chronic primary insomnia.

An individualized and guided session, under constant supervision, has been conducted for each participant.



Post-test Assessment: (SBP), (DBP), and (HR) were assessed in the sitting position after 5 minutes of the exercise session. (AIS) Scores were assessed on the day following the exercise session. To assess daytime doziness among samples during the day after the exercise, ESS was assessed two days after the exercise session. These post-test scores were used as the outcome measures.

RESULTS AND DATA ANALYSIS

Data Analysis Strategies: IBM SPSS Statistics for Windows (Version 21.0, IBM Inc., Armonk, NY, USA) has been used for data analysis.

Table 1: Gender

Gender	Number of Participants (n)	Percentage (%)
Male	10	32.3
Female	21	67.7

A total of 31 physiotherapy students were recruited in this study. Based on Table 1, the study involved 10 male students (32.3%) and 21 female students (67.7%).

Table 2: Age of participants

Age	Number of Participants (n)	Percentage (%)	Mean (SD)
19	11	35.5	
20	9	29.0	
21	5	16.1	20.23 (1.203)
22	5	16.1	
23	1	3.2	

SD = Standard deviation

The analysis of participants' demographic data is presented in Table 2. The age of the participants ranged from 19 to 23 years old, with a mean age of 20.23 years (SD = 1.203). There were 11 participants (35.5%) who were 19 years old. 9 participants (29.0%) were aged 20 years, 5 participants (16.1%) were 21 years old, 5 participants (16.1%) were 22 years old, and only 1 participant (3.2%) was 23 years old.

Table 3: RHR, MHR, and HRR of participants.

	Mean	Standard Deviation
RHR	91.81	11.95
MHR	199.71	1.22
HRR	107.90	11.44

Analysis of resting heart rate (RHR) among the participants in Table 3, shows a mean value of 91.81 (SD = 11.951). The maximum heart rate (MHR) of the participants was 199.71 (SD = 11.96), while the heart rate reserve (HRR) was 107.90 (SD = 11.44).

Table 4: Mean of pre-test resting heart rate (RHR) and post-test resting heart rate (RHR)

	Means (SD)	Mean Difference (SD)	95% CI	T	p value
Pre-test RHR	91.81 (11.95)	-12.74 (9.42)	-16.20 -9.29	-7.53*	p<0.001
Post-test RHR	104.55 (9.66)				

*A paired-samples t-test was performed, with a level of significance at p<0.05.

In Table 4, the resting heart rate (RHR) values for participants are shown to be generally distributed before and after exercise. Analysis of paired samples t-test has shown that the mean of participants' resting heart rate (RHR) before the exercise was 91.81 bpm (SD = 11.95), while the mean resting heart rate (RHR) after the exercise session was 104.55 bpm (SD = 9.66). The mean difference has shown an increase in the resting heart rate (RHR) by 12.74 bpm (SD = 9.42). The mean difference between pre-test resting heart rate (RHR) and post-test resting heart rate (RHR) is statistically significant (p<0.001).

Table 5: Mean of pre-test blood pressure and post-test blood pressure.

	Means (SD)	Mean Difference (SD)	95% CI	T	p value
Pre-test (SBP)	115.48 (14.99)	0.58 (10.72)	-3.35 4.51	0.30	p>0.05
Post-test (SBP)	114.90 (13.46)				
Pre-test (DBP)	73.65 (9.01)	0.16 (9.47)	-3.31 3.64	0.10	p>0.05
Post-test DBP	73.48 (8.23)				

*A paired-samples t-test was performed, with a level of significance at p<0.05.

SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, CI = Confidence Interval, SD = Standard Deviation.

In Table 5, the data on systolic blood pressure (SBP) and diastolic blood pressure (DBP) indicate that the collected data were normally distributed. Analysis of paired samples using a t-test has shown a slight decrease in systolic blood pressure (SBP) before exercise, from 115.48 mmHg (SD = 14.99) to 114.90 mmHg (SD = 13.46), with a mean difference of 0.58 mmHg (SD = 10.72). For diastolic blood pressure (DBP), the mean before exercise was 73.65 mmHg (SD = 9.01). The mean diastolic blood pressure (DBP) after exercise has decreased slightly, by 0.16 mmHg (SD = 9.47), to 73.48 mmHg (SD = 8.23). However, the mean differences for both systolic blood pressure (SBP) and diastolic blood pressure (DBP) before and after the exercise session are not statistically significant, as p>0.05.

Table 6: Mean score of Pre-test and Post-test (AIS)

	Means (SD)	Mean Difference (SD)	95% CI	t	p value
Pre-test Athens Insomnia Scale (AIS)	8.74 (2.54)	3.194 (3.98)	1.73 4.65	4.47*	<0.001
Post-test Athens Insomnia Scale (AIS)	5.55 (4.27)				

*A paired-samples t-test was performed. The level of significance was kept at p < 0.05,

Confidence Interval (CI), standard deviation (SD)

In Table 6, the data collected for the pre-test Athens Insomnia Scale (AIS) and post-test Athens Insomnia Scale (AIS) show that they are normally distributed. Paired-samples t-test has shown that the mean score for the Athens Insomnia Scale (AIS) before the exercise intervention was 8.74 (SD = 2.54). In contrast, the Athens Insomnia Scale (AIS) after the exercise intervention was reduced to 5.55 (SD = 4.27). The mean difference between the pre-test Athens Insomnia Scale and the post-test Athens Insomnia Scale was statistically significant (p<0.001). The null hypothesis was rejected. We have found the association between AMIAE and the level of insomnia among university students. Furthermore, we also found an association between AMIAE and the level of insomnia among the participants (shown in Table 7).

Table 7: Mean score of pre- and post-Epworth Sleepiness Scale (ESS) scores.

	Means (SD)	Mean Difference (SD)	95% CI	T	p value
Pre-test Epworth Sleepiness Scale (ESS)	8.52 (3.99)	2.29 (3.44)	1.03 3.55	3.71*	p<0.001
Post-test Epworth Sleepiness Scale (ESS)	6.23 (4.30)				

*A paired-samples t-test was performed, with a level of significance at p<0.05.

To conclude, the values for the Pre-test Epworth Sleepiness Scale (ESS) and post-test Epworth Sleepiness Scale (ESS) were normally distributed. A paired-samples t-test revealed that the mean score for the pre-test Epworth Sleepiness Scale (ESS) was 8.52 (SD = 3.99), while the post-test Athens Insomnia Scale (AIS) score decreased from 2.29 (SD = 3.44) to 6.23 (SD = 4.30). The mean difference between the pre-test Athens Insomnia Scale and the post-test Athens Insomnia Scale is statistically significant (p<0.001), as shown in the table. The null hypothesis was rejected.

DISCUSSION

According to practice recommendations for the role of physiotherapy in the management of sleep disorders: the 2022 Brazilian Sleep Association Guidelines (Frange et al., 2022) [34] has suggested exercises with an intensity moderate to intense, for a duration minimum of 50

minutes (3 times a week) or at least 150 minutes a week. This statement aligns with "The European Guideline for the Diagnosis and Treatment of Insomnia," which also recommends physical exercise as an adjunctive treatment for patients with insomnia. (Riemann et al., 2023) [35].

Insomnia level: In this study, after a single session of moderate-intensity aerobic exercise, the level of insomnia was significantly reduced by a mean of 3.19 (SD = 3.98).

In a review article, Korkutata et al. (2025) [36] suggest that, based on practical principles, moderate aerobic exercises can be recommended as an effective non-pharmacological strategy for addressing sleep disturbances. Exercise may enrich sleep quality in several ways. Moreover Korkutata et al., 2025 also has discussed various perspectives on the effect of exercise on the body and sleep as it may lead to an increase in growth hormones, increases core body temperature (Tc), slow wave sleep as well as the total sleep time, decrease insulin resistance and inhibit vagal activity [36]. The combination of aerobic and resistance exercise may enhance the quality of sleep among patients with insomnia, while also improving subjective sleep quality and sleep duration, and reducing daytime dysfunction associated with sleep problems. (Haleh Dadgostar et al., 2023) [37]. In a randomized controlled trial conducted by Hartescu et al. (2015) on the effects of physical activity on sleep and mood, it was also demonstrated that physical activity significantly reduced the severity of insomnia by decreasing anxiety and depression scores, ultimately leading to improved mood and sleep [38].

In research conducted by Passos et al. (2010) on four groups (control, moderate-intensity aerobic exercise, high-intensity aerobic exercise, and moderate-intensity resistance exercise), the researchers concluded that acute moderate-intensity aerobic exercise appears to reduce pre-sleep anxiety and improve sleep among patients with chronic primary insomnia [33]. A rise in core body temperature associated with exercise, followed by a drop in temperature after around 30 to 90 minutes, may help facilitate sleepiness. (Exercising for Better Sleep, 2019) [39].

Daytime Sleepiness: Our findings of the study has also shown improvement in mean difference (MD) 2.29 (3.44) in (ESS) is well in the alignment with a study in which the intervention group has been subjected for a 12-week intervention of aerobic exercise for 3 days per week and resistance training for another 3 days the week. Korkutata et al. (2025), Xie et al. (2021), and Baron et al. (2013) have suggested that exercise is particularly beneficial for addressing sleep challenges, such as insomnia, excessive daytime sleepiness, and sleep apnea [36, 40, 41].

These findings are also reinforced and further explored in a systematic review and meta-analysis of randomized controlled trials conducted by Xie et al., 2021 on assessing the impact of effects of exercise on sleep quality and insomnia which concluded that the short-term interventions (≤3 months) had a much more and valued decrease in sleep disturbance if being compare upon to a long-term intervention (>3 months) [40]. Kwon and Shin (2016) also suggested that consistent exercise has a protective role in EDS prevention [42].

Heart Rate: A cross-sectional study conducted by Amirreza Sajjadieh et al. (2020) among a total of 260 staff members at a university in Iran concluded that poor sleep quality is negatively associated with parameters of HRV, HR, and BP [43]. Roeser et al. (2012) in a study to explored differences in heart rate variability and further cardiovascular measures in both morning and evening types at rest and in stress at dissimilar times of day. The study concluded that the increased physiological awakening in evening types may also contribute to an accelerated susceptibility to psychological suffering. Evening types had substantially higher heart rates and systolic blood pressure; however, they had lower heart rate variability compared to morning types at baseline and during stress [44]. Mohamad et al 2021, in a cross-sectional study to assess the prevalence and risk factors of anxiety among university students in Malaysia, has observed the prevalence of anxiety at 29%. This study also explored the significant association of various factors, including poor sleep quality, active involvement in society, and doubt about the future, with the risk of anxiety. The findings can serve as a baseline for precise interventional strategies according to specific issues [45]. Anxiety can lead to psychosomatic issues and may lead to sleep disturbance, and so a decrease in exercise-associated reduction in anxiety can help to improve sleep.

Blood Pressure: Although the mean values for both components of blood pressure in our study were not statistically significant, the results still indicate a slight reduction in systolic blood pressure (SBP) and diastolic blood pressure (DBP) among the participants. This finding is in aligned with a prospective cohort study conducted by Liu et al. (2022), which evaluates the association between hypertension and insomnia, suggesting a probable bidirectional relationship between insomnia and hypertension [46] also pondered on the importance of early recognition and avoidance of insomnia in patients with hypertension, and vice versa. Physiologically, an increased heart rate will be followed by a decrease in heart rate. In an experimental study, Javorka et al. (2002) concluded that the cardio deceleration rate is not dependent on HRV parameters during the period of rest; nonetheless, it is linked to the initial post-exercise retrieval of HRV parameters, which suggests a parasympathetic involvement at this stage [47]. A systematic review with meta-analysis by Casanova-Lizón et al. (2022) suggested that exercise training enhances cardiac parasympathetic nervous system (PNS) modulation among sedentary individuals, while its effect on PNS tone requires further investigation [48].

In the conclusion, the level of insomnia measured has shown a significant reduction after the single bout of exercise session ($p < 0.001$). The mean score for AIS has reduced by 3.194 (SD = 3.98) from 8.74 (SD = 2.54) before the exercise to 5.55 (SD = 4.27) after the exercise session.

Furthermore, the daytime sleepiness score, measured using the ESS, has also shown improvement. The mean scores of (ESS) have shown a significant reduction as much as 2.29 (SD = 3.44), that is, from 8.52 (SD = 3.99) before the exercise session to 6.23 (SD = 4.30) after the single exercise session.

Conclusion, significance, and contribution of the study:

This study has shown the positive influences of (AMIAE) on the various attributes of sleep among young insomniac University students. An attempt was made to control for the impact of confounding variables, such as temperature and the timing of exercises, by conducting them in the same environment. Primary insomnia, behavioral Insomnia disorders, delayed circadian rhythm sleep disorders, unhealthy eating habits, associated inevitable stress with academic pressure, and psychological stress may leave the students quite vulnerable and prone to insomnia. Nonpharmacological management, such as physiotherapy with a specifically tailored set of exercises, breathing techniques, and other physiotherapy methods, should be explored further as an alternative and viable option. This research also expands the scope of physiotherapy in the field of sleep medicine. Exercise and healthy habits may lay the foundation for today's students, who are the future of tomorrow's world. Practicing good quality, quantity, and regularity of sleep during higher education can have a significant impact.

LIMITATIONS AND RECOMMENDATIONS OF THE STUDY

As this study was conducted on young individuals, it may be challenging to generalize the findings to all age groups. The impact of various intensities of exercise on individuals with primary insomnia or primary insomnia disorders should also be further assessed. More vigilance and control over all the potential confounding variables should be considered. Factors such as the type of mattress, bed, sleeping position, and environmental influences (including cultural practices, pre-sleep bathing, room temperature, exposure to sunlight, and the use of artificial light) require further evaluation. Students are prone to many psychological issues such as stress, anxiety, nervousness, and depression; this should be evaluated further. Insomnia associated with circadian rhythm disorders should also be assessed for the impact of exercises done at different times and also, can be studied further with a combination of bright light therapy. Combination of cognitive behavioral therapy I (CBT-I) (Riemann et al., 2023) (35) should also be considered. Pittsburgh sleep quality index (PISQ) (University of Pittsburgh, 2024) [49], Subjective sleep scale (Fabbri et al., 2021) [50], and sleep diary (TWO WEEK SLEEP DIARY), n.d., (Carney et al., 2012) [51,52] could also be considered for the subjective assessment of sleep. Additionally, one must also consider actigraphy, smartwatches, fitness trackers, and various software, which can be used after assessing and weighing their reliability and validity beforehand. Assessing the impact of exercises on physiological parameters, such as ventilatory variables (minute ventilation, VE), oxygen consumption (VO2), and carbon dioxide production, as well as changes in heart rate variability and blood pressure, can further enhance rationalization and increase acceptance of the effectiveness of exercise in management. Polysomnography remains one of the most effective options for assessing the impact.

Another conceivable and perhaps doable concept is to award marks, certificates, or acknowledge a student (with clear policies that are inclusive for students with physical and other challenges) in some way for achieving an optimal weight, BMI, and physical fitness in the course. This can make a massive difference at the grassroots level. Incorporating sleep hygiene knowledge and practices among high school and university students can make a significant difference at the grassroots level. Mindfulness, yoga, and other traditional practices should also be supported by further research. The option of breathing exercises (in combination or standalone treatment) should be explored further in the management of sleep disorders, especially for the busy population. In addition to the potential benefit of improving sleep, exercise offers numerous other benefits. Encouragement of regular exercise and health practices at the school, college, and university levels can be facilitated by providing gymnasiums and parks. By designing individualized, tailored protocols based on the principle of specificity, physiotherapists can explore and contribute more to the field of Sleep Medicine.

Permission and approval:

This study was approved by the Institute of Postgraduate Studies and Research (IPSR) - Universiti Tunku Abdul Rahman (UTAR), Sungai Long campus, Malaysia.

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