International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effect of Aerobic versus Anaerobic Exercise on Sleep Quality among Paramedical Students

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Abstract

Background: Studies shows high prevalence of sleep problem among students. The current study, intends to find the effects of exercises in enhancing quality of sleep among paramedical students.

Objective: To compare the effect of aerobic and anaerobic exercise on disturbed sleep quality among paramedical students.

Design: A Randomized control trial (RCT) was conducted on 30 healthy paramedical students for a period of 6 weeks. Subjects were randomly sampled and allocated to Group A and Group B. Group A performed aerobic exercise and Group B performed anaerobic exercise for 6 weeks. Two outcome measures PSQI (Pittsburgh sleep quality index) and ESS (Epworth sleepiness scale) were obtained and pre-post intervention measures were analyzed.

Result: In this study, the improvement in sleep quality was observed in both aerobic and anaerobic group with p value > 0.01 for both the group. Anaerobic group showed better improvement post intervention as compared to aerobic group with mean difference between them being 1.13(0.67) and 1.0(0.65) respectively. However, there was no statistically significant difference between the two groups with p value > 0.05.

Conclusion: Both aerobic and anaerobic exercise has positive effect on disturbed sleep quality with anaerobic exercise demonstrating greater effect when compared with aerobic exercise.

Keywords: Sleep quality, aerobic exercise, anaerobic exercise.

1. Introduction

Sleep is essential for maintaining optimal physical health, psychological well-being, cognitive functioning and overall quality of life. Studies suggest that adults require nightly sleep duration of 7 to 9 hours, in order to maintain optimal health[28]. University students across diverse academic disciplines, encompassing medical, nonmedical, and nursing domains, commonly have compromised sleep quality. An investigation centered on medical students across Asian regions has uncovered a considerably elevated prevalence rate of 47.44% pertaining to suboptimal sleep quality within this demographic[5]. Deviations from healthy sleep patterns can affect both psychological and physical dimensions as well as compromise their academic and clinical performance.

Over the long term, inadequate sleep has been correlated with the emergence of metabolic disorders, notably including obesity and type 2 diabetes mellitus and heightens the risk of hypertension and cardiovascular diseases[6]. Mood disorders, encompassing anxiety and depression, can also be exacerbated or triggered by insufficient sleep and it also leads to increased daytime sleepiness and fatigue[6,31].

Both pharmacological and non-pharmacological modalities are used as an intervention for poor sleep. Physical exercise stands as a prominent non-pharmacological modality for disturbed sleep, characterized by its cost-effectiveness, safety, and widespread accessibility. Enhanced sleep quality achieved through regular exercise results in diminished daytime fatigue, thereby optimizing daytime alertness and vitality[8,32].

Studies have indicated that both aerobic and anaerobic exercises yield positive effects on sleep quality. Exercise enhances sleep quality through thermoregulation, vagal modulation, post exercise hormonal shifts, increased level of BDNF etc[1,8,30]. In 2017 Brett A Dolezel et al conducted systematic review and reported that physical activity is an effective intervention for improving sleep quality however, there are limited studies assessing the impact of different types of exercise on sleep quality. Thus, this study aimed at determining the optimal exercise modality for enhancing sleep quality. By comparing the effects of aerobic and anaerobic exercises on sleep quality, particularly among paramedical students, this research seeks to bridge existing knowledge gaps and provide actionable insights for improving sleep quality within this vulnerable population.

2 Materials and Methods

2.1 Study design

This study was a randomized controlled trial conducted to compare the effects of aerobic and anaerobic exercise on sleep quality and daytime sleepiness among paramedical students with disturbed sleep quality.

2.2 Participants and eligibility criteria

The study was conducted among undergraduate students from the Nursing, Physiotherapy, and Pharmacy colleges in Bangalore. Ethical approval was obtained from the Ethical Committee team of Rajiv Gandhi University of Health and Sciences (RGUHS), Karnataka before commencement of the study.

The required sample size was calculated using the formula N=2(SD)2(Zα/2+Zβ)2/d2N = 2(SD)^2 (Z_{\alpha/2} + Z_\beta)^2 / d^2N=2(SD)2(Zα/2+Zβ)2/d2, with an effect size (d) of 1.59, standard deviation (SD) of 2.21, Zα/2=1.96Z_{\alpha/2} = 1.96Zα/2=1.96, and Zβ=0.842Z_\beta = 0.842Zβ =0.842, resulting in a required sample size of 30 participants. Eligible participants were recruited after screening according to the predefined inclusion and exclusion criteria.

Before enrolment, all participants were informed about the purpose, procedures, potential benefits, and possible risks of the study. Written informed consent was obtained from each participant prior to data collection.

2.3 Inclusion criteria

Participants were eligible for inclusion if they were undergraduate paramedical students aged between 18 and 26 years with a history of disturbed sleep for at least three months. Additionally, participants were required to fulfill any two of the following three sleep-related criteria: sleep onset latency of ≥30 minutes, wake after sleep onset occurring ≥3 times per night, and total sleep duration of <7 hours.

2.4 Exclusion criteria

Participants were excluded if they engaged in regular physical activity, including gym training, sports, or structured home exercise; had any musculoskeletal injury or had undergone recent surgery; had a diagnosed psychiatric disorder; had diagnosed respiratory or cardiovascular disease; were taking sleep medications or any medications known to influence sleep or cause fatigue; or had a history of regular alcohol consumption, smoking, or substance abuse.

2.5 Experimental procedure

After randomization, baseline demographic information was collected using a participant proforma. All participants underwent a pre-participation screening examination. Baseline assessments of sleep quality and daytime sleepiness were performed using the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS).

Both intervention groups participated in supervised exercise sessions for six weeks.

Group A (aerobic exercise): Participants performed moderate-intensity brisk walking according to the American College of Sports Medicine (ACSM) recommendations. They followed either 30 minutes/day for 5 days/week or 50 minutes/day for 3 days/week, ensuring a minimum of 150 minutes of moderate-intensity aerobic exercise per week for six weeks.

Group B (anaerobic exercise): Participants performed an anaerobic exercise program comprising 30-m sprinting, squats, sit-ups, and push-ups, three sessions per week for six weeks. Exercise intensity and repetitions were progressively increased according to participants' tolerance.

Each exercise session for both groups consisted of a 10-minute warm-up, followed by the prescribed exercise program, and concluded with a 10-minute cool-down. Weekly compliance reports were collected throughout the intervention period.

At the end of the six-week intervention, all participants were reassessed using the PSQI and ESS.

2.6 Outcome measures

2.6.1 Pittsburgh Sleep Quality Index (PSQI)

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), a validated self-administered questionnaire consisting of 19 items grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Component scores range from 0 to 3, yielding a global score between 0 and 21, with higher scores indicating poorer sleep quality.

2.6.2 Epworth Sleepiness Scale (ESS)

Daytime sleepiness was evaluated using the Epworth Sleepiness Scale (ESS), an eight-item self-reported questionnaire that measures the likelihood of falling asleep during common daily activities. Each item is scored from 0 to 3, resulting in a total score ranging from 0 to 24. Higher scores indicate greater daytime sleepiness.

3 Statistical analysis

Descriptive statistics were used to summarize the demographic characteristics and outcome measures of the participants and are presented as mean ± standard deviation (SD). Inferential statistics were used to test the hypothesis of the study. Baseline characteristics of the participants were analyzed using the **Chi-square test**. Within-group comparisons of pre- and post-intervention changes in the **Pittsburgh Sleep Quality Index (PSQI)** and **Epworth Sleepiness Scale (ESS)** scores for both groups were performed using the **paired t-test** to determine the effect of the intervention over time. Intergroup comparisons of changes in PSQI and ESS scores between the two groups were analyzed using the **independent (unpaired) t-test**. A two-tailed p-value of <0.05 was considered statistically significant.

4 Results

A total of 30 paramedical students with disturbed sleep quality completed the study and were randomly allocated into the aerobic exercise group (Group A, *n* = 15) and anaerobic exercise group (Group B, *n* = 15). The baseline characteristics of the participants are presented in **Table 1**. The mean age of the participants was 23.6 years. No statistically significant differences were observed between the groups in terms of age (*p* = 1.000) and gender distribution (*p* = 0.269), indicating that both groups were comparable at baseline (Table 1 and Table 2).

Table 1: Comparison of mean age between Group A and Group B respectively

	Mean	SD	Mean Difference (SE)	Unpaired t test	P value, Significance
Group A (Aerobic)	23.6	1.4	0.0 (0.59)	t = 0.0	P =1.000
Group B (Anaerobic)	23.6	1.8			

Graph 1: Comparison of mean age between Group A and Group B respectively

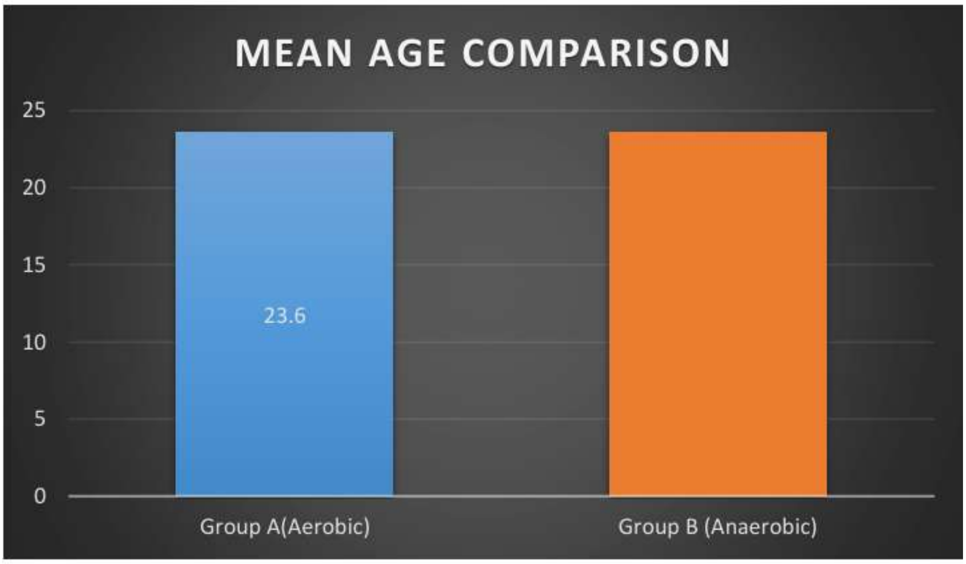
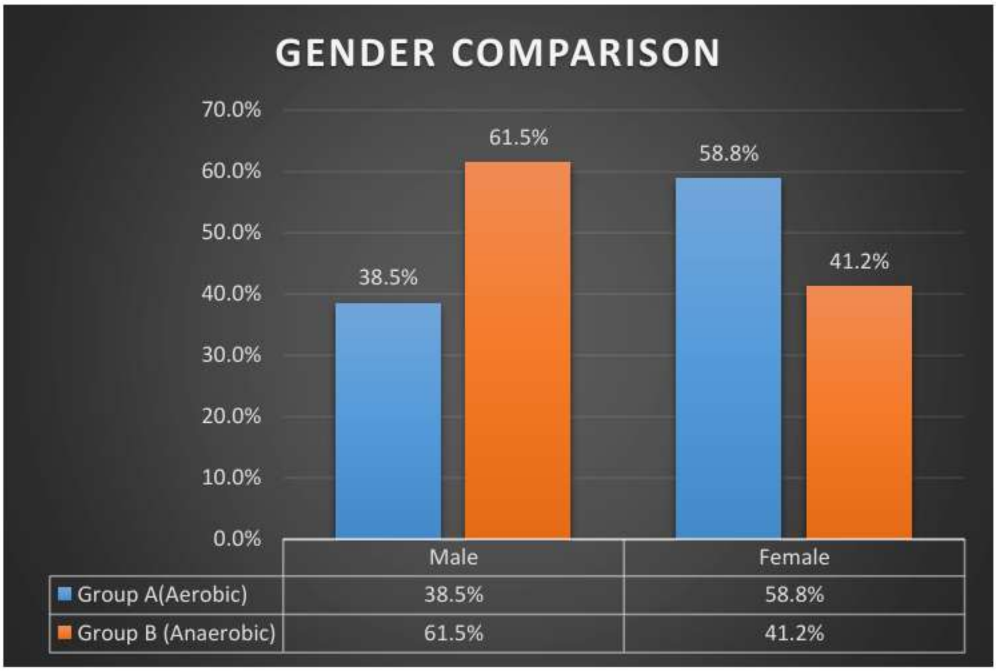


Table 2: comparison of gender between Group A and Group B respectively

	Male N (%)	Female N (%)	Chi square test	P value, Significance
Group A (Aerobic)	5 (38.5%)	10 (58.8%)	Chi = 1.22	p = 0.269
Group B (Anaerobic)	8 (61.5%)	7 (41.2%)		

Graph 2: comparison of gender between Group A and Group B respectively



Following the six-week intervention, both groups demonstrated significant improvements in sleep quality and daytime sleepiness. The mean PSQI scores significantly decreased in both Group A and Group B ($p < 0.001$). Similarly, ESS scores showed significant reductions in Group A ($p = 0.004$) and Group B ($p < 0.001$), indicating improved sleep-related outcomes following the intervention (Table 3, and Table 4).

Table 3: Intra-group comparison from pre to post intervention in respect to PSQI scores in both groups

	Pre-score Mean (SD)	Post-score Mean (SD)	Mean Difference (SE)	Paired t test	P value, Significance
Group A (Aerobic)	10.53 (1.68)	5.26 (1.7)	5.26 (0.61)	t = 8.498	p<0.001**
Group B (Anaerobic)	11.33 (1.95)	4.93 (1.22)	6.4 (0.59)	t = 10.762	p<0.001**

Graph 3: Intra-group comparison from pre to post intervention in respect to PSQI scores in both groups

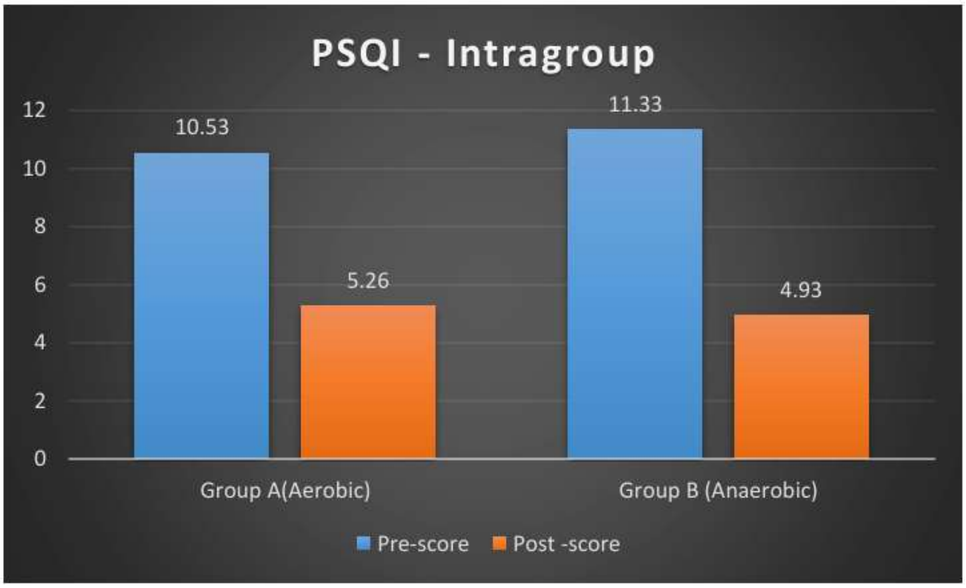
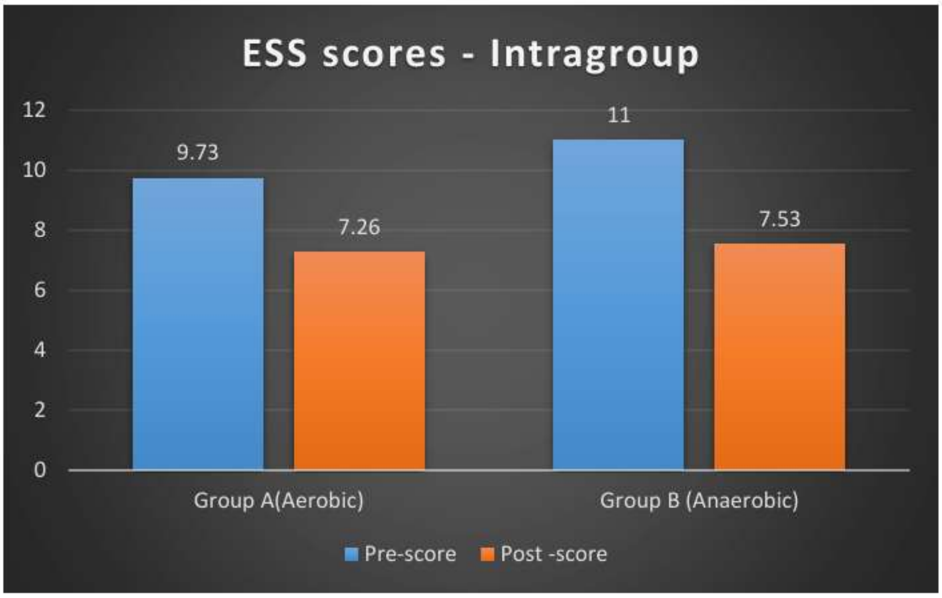


Table 4: Intra-group comparison from pre to post intervention in respect to ESS scores in both groups

	Pre-score Mean (SD)	Post-score Mean (SD)	Mean Difference (SE)	Paired t test	P value, Significance
Group A (Aerobic)	9.73 (2.31)	7.26 (1.9)	2.46 (0.77)	t = 3.186	P=0.004*
Group B (Anaerobic)	11.0 (2.1)	7.53 (1.95)	3.46 (0.74)	t = 4.670	p<0.001**

Graph 4: Intra-group comparison from pre to post intervention in respect to ESS scores in both groups



The between-group comparison of changes in PSQI and ESS scores is presented in **Table 3**. Although a greater reduction in PSQI and ESS scores was observed in the anaerobic exercise group compared with the aerobic exercise group, the differences between groups were not statistically significant (PSQI: p = 0.106; ESS: p = 0.137) (**Table 5**).

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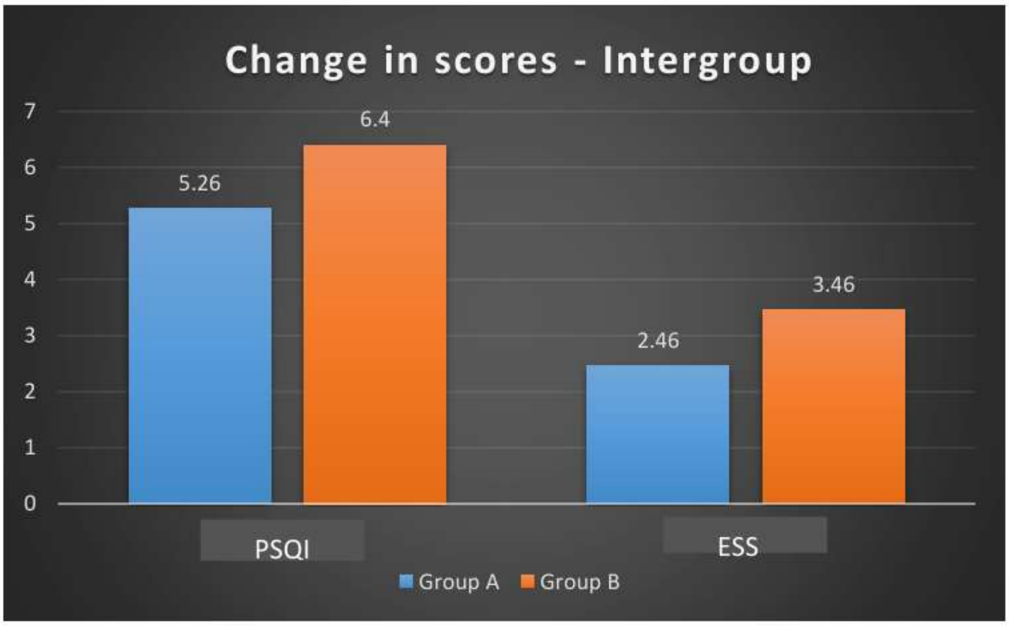
Table 5: Intergroup comparison of change in PSQI and ESS score from pre to post intervention between both groups

	Group A (Aerobic) Mean (SD)	Group B (Anaerobic) Mean (SD)	Mean Difference (SE)	Unpaired t test	P value, Significance
Change/ Decline in PQSI	5.26 (1.57)	6.4 (2.09)	1.13 (0.67)	t = -1.672	p= 0.106 (NS)
Change/ Decline in ESS	2.46 (1.92)	3.46 (1.64)	1.0 (0.65)	t = -1.532	p = 0.137 (NS)

Graph 5: Intergroup comparison of change in PSQI and ESS score from pre to post intervention between both groups



5 Discussion

The present study evaluated the effectiveness of aerobic and anaerobic exercises in ameliorating disturbed sleep quality among paramedical students. The Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS) were used as the primary and secondary outcome measures, respectively. PSQI was designated as the primary outcome measure due to its validated utility across diverse clinical populations and its ability to distinguish individuals with "good" or "poor" sleep patterns, making it applicable in both clinical and research settings[19]. The ESS, as a secondary outcome measure, gauges daytime sleepiness, an important indicator of sleep irregularities, and is widely used in both research and clinical assessments[20].

The baseline characteristics of both groups were comparable, with no statistically significant difference. Following 6 weeks of intervention, both aerobic (Group A) and anaerobic (Group B) exercise significantly improved sleep quality and reduced daytime sleepiness, as reflected by lower PSQI and ESS scores. Although greater improvement was observed in the anaerobic group, the difference between the groups was not statistically significant.

A multitude of investigations have demonstrated the favorable impact of diverse exercise modalities on the enhancement of sleep quality. Numerous studies mirror findings similar to those of the current study. For instance, Xie Y et al. reported that exercise improved sleep quality, reduced insomnia severity, and alleviated compensatory daytime sleepiness in adult participants[13]. Similarly, Maryam Ezati et al. demonstrated improved sleep quality and reduced daily fatigue following eight weeks of aerobic training among female nursing students[37]. Gupta S et al. further reported that resistance training improved sleep duration, sleep efficiency, and sleep latency, while also enhancing the overall quality of life in older adults with sleep disturbances, comparing favorably with aerobic exercise[14]

In contrast to our study, Kamran Ali et al. reported no discernible enhancement in sleep quality among collegiate athletes following a six-week regimen of anaerobic training, although there was no observable decline after the intervention[35]. Similarly, a systematic review and meta-analysis by Amir R. Memon et al. reported no significant correlation between physical activity level and sleep quality among university students. This lack of correlation might be attributable to lifestyle factors such as screen time, dietary habits, emotional disposition, light exposure, and related factors influencing sleep patterns[36].

The observed enhancement in sleep quality among Group A can be attributed to the favorable impacts of aerobic exercises on factors such as brain-derived neurotrophic factor (BDNF), serotonin, and norepinephrine levels, thereby improving sleep quality. Elevated BDNF levels following aerobic exercises help counteract anxiety, depression, and mood disturbances commonly associated with sleep disruptions. Moreover, the release of serotonin and norepinephrine facilitated by aerobic exercises plays a critical role in promoting high-quality sleep. Furthermore, aerobic exercise favorably modulates elevated cortisol levels associated with sleep disorders, thereby potentially contributing to improved sleep patterns[8,30].

The improvement observed in anaerobic group may be attributed to increased energy expenditure and fatigue, which may enhance sleep. However, the underlying mechanisms by which resistance exercise improves sleep remain incompletely understood[9,14,22].

Significant enhancements in both the groups post intervention can be elucidated based on several hypotheses, encompassing thermogenic, body restoration, and energy conservation rationales. Increased post-exercise body temperature promotes heat dissipation, thereby promoting onset of sleep, while greater energy expenditure increases the body's restorative sleep requirements. The body restoration hypothesis suggests that sleep helps recover from the physiological demands of exercise, supporting exercise as a stimulus for sleep initiation[29,30,33,37].

The intricate interplay between these hypotheses underscores the multifaceted nature of the relationship between exercise and sleep. The thermogenic response, energy restitution imperative, and body rejuvenation framework collectively contribute to the comprehensive understanding of how exercise acts as a catalyst for fostering optimal sleep patterns.

6 Conclusion

Poor sleep quality is common among paramedical students. In this study, both aerobic and anaerobic exercise were found to have positive effect on sleep quality and compensatory daytime sleepiness. However, anaerobic exercise showed greater improvement when compared to aerobic exercise. Thus, students should be encouraged to indulge in regular exercise including both aerobic and anaerobic exercises as exercise is a recommended non pharmacological approach to improve sleep quality and it is easily accessible with minimum risk.

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