JVHS

Research Article

e-ISSN: 2147-7892
Published: February 2026
https://dergipark.org.tr/en/pub/inonusaglik

THE EFFECT OF AEROBIC EXERCISE TRAINING ON PHYSIOLOGICAL COST INDEX, PHYSICAL ACTIVITY, FUNCTIONAL CAPACITY, FATIGUE AND SLEEPINESS IN HEALTHY YOUNG ADULTS

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Citiation: Gönen, T., Dinler, E., & Yakut, Y. (2026). The effect of aerobic exercise training on physiological cost index, physical activity, functional capacity, fatigue and sleepiness in healthy young adults. *Journal of İnönü University Health Services Vocational Schoo*l, 14(1), 196–207.

doi 10.33715/inonusaglik.1795356

Received: October 2, 2025 / **Accepted:** January 19, 2026

Abstract

This study aimed to investigate the effects of combined aerobic and respiratory exercise training on the physiological cost index, physical activity, functional capacity, fatigue, and daytime sleepiness in healthy young adults. A total of 107 healthy young adults (aged 19–37 years) participated in the study. Participants engaged in moderate-intensity aerobic exercise at 60% of their maximal heart rate for 150 minutes per week over eight weeks. To enhance the effectiveness of the aerobic exercise program, respiratory training was provided prior to its commencement. The physiological cost index was calculated as(heart rate during walking – resting heart rate) / walking speed (m/min). Physical activity levels were assessed using the International Physical Activity Questionnaire-Short Form. Functional capacity was evaluated with the 6-Minute Walk Test, fatigue levels with the Fatigue Severity Scale, and daytime sleepiness levels with the Epworth Sleepiness Scale. No statistically significant changes were observed in the physiological cost index or overall physical activity level following the intervention, although favorable shifts in the distribution of physical activity categories were noted; these shifts were not statistically significant ($p > 0.05$). Functional capacity increased significantly after the intervention ($p = 0.001$). Fatigue levels decreased ($p = 0.004$), and daytime sleepiness levels also changed significantly ($p = 0.020$). Moderate-intensity aerobic exercise training was associated with higher functional capacity, lower fatigue levels, and reduced daytime sleepiness among healthy young adults.

Keywords: Aerobic exercise, Functional capacity, Physical activity, Physiological cost index, Young healthy adult

INTRODUCTION

Physical inactivity is one of the leading risk factors for non-communicable diseases and mortality worldwide. According to data from the World Health Organization, regular participation in physical activity reduces the incidence of several highly prevalent diseases, such as cancer, cardiovascular disease, diabetes, and depression. While the global proportion of adults who engage in exercise is around 25%, this rate rises to nearly 80% among younger individuals (Tuncay et al., 2004). Furthermore, in adults, regular exercise reduces the risk of death from various causes and lowers the risk of cardiovascular disease (including hypertension), cancer, diabetes, falls, and sleep disorders. It also enhances mental health, cognitive abilities, overall health and well-being, and sleep quality (Janssen 2007).

Regular physical activity performed with correct breathing patterns is associated with a lower energy expenditure, as reflected in the physiological cost index. Individuals without a regular exercise habit tend to expend more energy during physical activity. The result is associated with decreased physical fitness and increased fatigue (Ayán-Pérez et al., 2024). Additionally, the coordinated functioning of different body segments reduces physiological energy cost. Disruption of inter-segmental coordination increases this expenditure (Waters & Lunsford, 1985). Regular physical activity and appropriate respiratory exercises can also help maintain proper posture and dynamic coordination of body segments (Salsali et al., 2023; Skelton 2001). Studies conducted after the COVID-19 pandemic have indicated a significant decrease in physical activity levels among university students (López-Valenciano et al., 2021). Increasing students' physical activity levels is crucial for them to experience the full benefits of physical activity. Regular aerobic exercise has been shown to enhance physical activity and functional capacity not only in healthy individuals but also in various patient populations (Linder et al., 2021; Liu et al., 2022; Ismail 2022).

Regular aerobic activity is considered an effective method for reducing fatigue and improving sleep quality (Ezati et al., 2022). Research has demonstrated that academic stress experienced by university students increases their feelings of fatigue, which significantly disrupts their sleep quality. Moreover, research has shown that promoting regular exercise habits is a highly effective strategy for managing academic stress, fatigue, and sleep disorders (Li et al., 2022).

To our knowledge, no study has examined the effects of regular aerobic exercise on all of these variables. Therefore, the aim of our study is to investigate the effects of combined aerobic and respiratory exercise training on the physiological cost index, physical activity, functional capacity, fatigue, and daytime sleepiness in healthy young individuals.

MATERIAL AND METHOD

Study Regions

This study was planned as a single-group, pretest–posttest quasi-experimental design between February and June 2024. The study was conducted with students aged 18–37 years from various faculties and departments at Hasan Kalyoncu University who took a course offered by the Department of Physiotherapy and Rehabilitation as a university-wide elective. Among the students enrolled in the course, those with chronic diseases, any contraindications to aerobic exercise, or a surgical history involving the lower extremities in the past six months were excluded from the study. Individuals who declined to participate in the study were also excluded. Of the 120 students who enrolled in the course, 10 did not actively participate and 3 did not meet the study criteria; thus, the study commenced with 107 students who met the inclusion criteria.

The aerobic exercise program (walking) was planned to last eight weeks, totaling 150 minutes per week. The training was conducted in groups outdoors, supervised by an experienced physiotherapist. To enhance the effectiveness of the aerobic activity, respiratory exercises were added to the program. These exercises were demonstrated to all students once, before the training program began, and they were instructed to perform five daily. Prior to the commencement of the study, ethical approval was obtained from the Hasan Kalyoncu University Health Sciences Nonivasive Research Ethics Committee with the decision number 2024/23. The study is registered on ClinicalTrials.gov (ID: NCT06329115). All participants were informed about the purpose and content of the study in accordance with the Declaration of Helsinki, and after being provided with the necessary information, consent forms were explained to participants and signed. No students were excluded during the study, which was completed with 107 participants (Fig. 1).

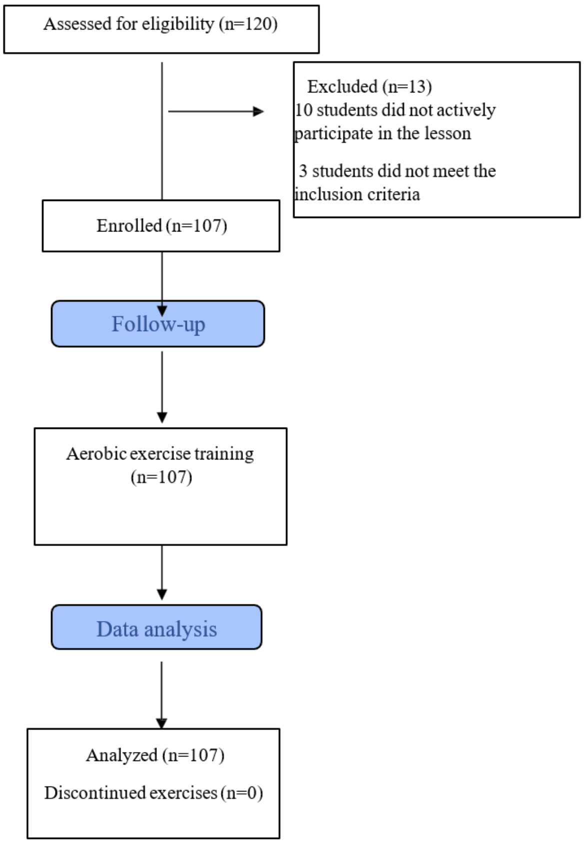

Figure 1. Study flowchart

Assessments

Students' physical and demographic information (gender, age, weight, height, dominant side, department, year of study, surgical history, and chronic diseases) was recorded at the beginning of the study. The physiological responses to exercise were assessed by calculating the physiological cost index. Physical activity was evaluated using the International Physical Activity Questionnaire-Short Form (IPAQ). The 6-Minute Walk Test was used to determine functional capacity. The Fatigue Severity Scale was used to assess fatigue, while daytime sleepiness levels were evaluated using the Epworth Sleepiness Scale.

Physiological Cost Index (PCI)

The physiological cost index (PCI) was calculated to assess the energy expenditure and walking effort of individuals. The PCI was calculated using the formula [PCI = (heart rate during walking – resting heart rate) / walking speed (m/min)]. Resting heart rate and heart rate during walking were measured using a pulse oximeter (Rana & Pun, 2015). The normal range of PCI values in healthy individuals is between 0.23 and [upper bound missing]. 0.42 beats/min (Özel et al., 2020).

International Physical Activity Questionnaire-Short Form (IPAQ)

The International Physical Activity Questionnaire-Short Form (IPAQ) was used to assess physical activity. The IPAQ Short Form provides information on time spent walking, in moderate- and vigorous-intensity activities, and sitting over the past 7 days (7 questions). The total score of the short form is calculated by summing the durations (minutes) and frequencies (days) of walking, moderate, and vigorous activities. The energy expenditure for each activity is calculated using the MET-minute score. Standard MET values have been established for these activities, and using these values, the daily and weekly physical activity levels are calculated (Dinler et al., 2020; Savcı et al., 2006).

6-Minute Walk Test (6MWT)

Functional capacity was assessed using the 6MWT. Participants were instructed to walk as fast as possible along a 30-meter straight corridor. They were informed that they could rest or stop the test if they experienced fatigue or shortness of breath. Standard encouraging phrases were used during the test (Singh & Puhan, 2014). At the end of the test, the 6MWT distance was recorded in meters. In healthy adults, the average 6MWT distance ranges from 400 to 700 meters. Distances below 400 meters indicate a decrease in functional capacity (Troosters et al., 1999).

Fatigue Severity Scale (FSS)

The severity of fatigue was assessed using the Fatigue Severity Scale (FSS), which was validated and had its reliability tested by Gencay et al. in 2012. The scale consists of 9 items, each scored from 0 to 7. The lowest possible score for an item is 0, and the highest is 7. The total score is divided by 9 to obtain the average score<4, it indicates no fatigue, while a score ≥4 indicates the presence of fatigue (Yakut & Yakut, 2011).

Epworth Sleepiness Scale (ESS)

Students' daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS), developed by John in 1992 and validated by Izci et al. in 2008. The scale consists of 8 items, with each item scored from 0 to 3. The scores for each item are summed to obtain a total score. The lowest possible score on the scale is 0, and the highest is 24. Scores are classified as follows: 0-5: normal; 6-10: normal but with increased daytime sleepiness; 11-12: mildly increased daytime sleepiness; 13-15: moderate daytime sleepiness; and 16-24: severe daytime sleepiness (Ayas et al., 2024).

Exercise Training

The exercise program consisted of eight weeks of moderate-intensity walking and breathing exercises. The appropriate heart rate for aerobic exercise was determined using the maximum heart rate formula (MHR = 220 − age). The Karvonen formula (target heart rate = intensity × (maximum heart rate minus resting heart rate) + resting heart rate) was used (Karvonen & Vuorimaa, 1988). Resting heart rates for each participant were measured using an exercise monitor while the participant lay supine for 10 minutes without activity. Participants engaged in walking or jogging at 60% of their maximum heart rate (submaximal intensity) totaling 150 minutes per week over eight weeks as moderate-intensity aerobic training. Heart rates were continuously monitored during exercise using the monitor to ensure that participants reached and maintained their target heart rate. Participants whose heart rate reserve deviated by ±5 were asked to adjust activity intensity. A pedometer application was installed on the participants' phones to record their step counts and exercise minutes.

To enhance the effectiveness of regular aerobic training and ensure that students could use their respiratory function effectively while walking, diaphragmatic and alternating nasal breathing exercises were taught. Participants were instructed to perform these exercises once daily for eight weeks, with five repetitions per session.

Diaphragmatic Breathing Exercise

Before performing diaphragmatic breathing exercises, participants were asked to rest for 1-2 minutes in a supine position on a flat surface with a pillow under their head and knees in a bent position. One hand was placed on the abdomen over the diaphragm, and the other on the upper chest wall. During inhalation, the hand on the abdomen was instructed to move upward, while the other hand remained as still as possible. During exhalation, the hand on the abdomen was instructed to move downward while the other hand remained as still as possible. Participants were asked to breathe slowly and deeplywithout becoming fatigued. They were instructed to inhale through the nose and exhale through the mouth. To prevent hyperventilation, they were taught to use controlled exhalation to gently expel all air (Sabancı & Barut, 2024).

Alternating Nasal Breathing Exercise

After diaphragmatic breathing exercises, alternating nasal breathing exercises were introduced. This exercise is designed to balance the brain's two hemispheres, focusing on improving concentration and awareness. During the exercise, participants were instructed to sit upright. First, they were asked to breathe with both nostrils open; then, while exhaling, they were instructed to close the right nostril with the right thumb and to exhale completely through the left nostril. Afterward, they were instructed to inhale through the left nostril, then close the left nostril, and exhale fully through the right nostril. Once a breath was taken through the right nostril, one cycle was considered complete; this cycle was repeated five times (Nautiyal et al., 2024).

Statistical Analysis

The SPSS software package, version 22.0 (IBM Corp., Armonk, NY), was used to analyze the study data. The descriptive statistics were summarized as the arithmetic mean and standard deviation (X ± SD) for numerical variables, and as frequency and percentage for categorical variables. The Kolmogorov–Smirnov test was used to determine whether the data were homogeneously distributed. The Wilcoxon signed-rank test was employed to compare non-normally distributed data. A paired t-test was used to compare pre- and post-treatment scores. The significance level was set at $p < 0.05$. The sample size was determined using the G*Power analysis program. In the analysis, when $d = 0.506$ and $n = 107$ were considered, the confidence level was 94%. Effect sizes (d) were defined as small (0.2), medium (0.5), and large (0.8). Effect size can be used to determine the true effectiveness of treatments and to estimate the statistical power of results.

RESULT

A total of 107 students participated in the study, of whom 80 (75%) were women and 27 (25%) were men; the mean age was 21.63 ± 3.56 years. Among the collected data, six MWT variables were found to be normally distributed according to the Kolmogorov-Smirnov test and were analyzed using parametric methods, whereas the remaining variables were analyzed using nonparametric methods. When the participants' class levels and academic departments were examined, 1.9% (n=2) were first-year students, 48.6% (n=52) were second-year students, 39.3% (n=42) were third-year students, and 10.3% (n=11) were fourth-year students. Regarding the distribution of participants across academic departments, 43% (n=47) were enrolled in the psychology department, 6.5% (n=7) in the business administration department, 8.4% (n=9) in the law department, 29.9% (n=32) in the physiotherapy and rehabilitation department, 3.8% (n=4) in the engineering department, and 7.5% (n=8) in the architecture department. Among the students, 86% (n=92) reported no chronic illnesses, whereas 14% (n=15) had chronic conditions that did not restrict exercise, such as bronchitis, sinusitis, or pharyngitis. Additionally, 23.4% (n=25) of the participants were smokers. The demographic characteristics of the students (age, height, weight, and BMI) are presented in Table 1.

Table 1. Demographic characteristics of the participants. Data are presented as mean ± SD

	n=107 Min-Max	n=107 X±SD
Age (year)	19-37	21.63±3.56
Length (m)	1.55-1.90	1.67±0.08
Weight (kg)	42-105	65.07±14.72
Body Mass Index (kg/m²)	17-35.80	23.09±4.17

M meter, Kg kilogram, Kg/m2 kilograms per square meter, BMI body mass index,

When examining the physiological cost index measurements following regular aerobic exercise training in the included students, a decrease was observed from pre-intervention to post-intervention; however, the difference was not statistically significant ($p > 0.05$). Results from the International Physical Activity Questionnaire-Short Form indicated that values before and after aerobic training did not differ significantly ($p > 0.05$). In addition to the total IPAQ scores, the categorical distribution of physical activity levels was analyzed. Prior to the intervention, 19.6% of participants were classified as having low physical activity, 54.2% as moderate, and 26.2% as high.

After the 8-week exercise program, the proportion of individuals in the moderate category increased to 67.0%, while the high and low categories decreased to 19.4% and 13.6%, respectively. The reduction in total IPAQ scores was not statistically significant according to a Wilcoxon signed-rank test ($z = -1.784$, $p = 0.074$). The effect size associated with this change was small ($d = -0.27$), indicating that, although categorical shifts suggested a general improvement in physical activity distribution, the overall change in IPAQ scores was limited. In the 6-minute walk test, post-intervention walking distance increased compared with pre-intervention, and the difference was statistically significant ($p = 0.001$). Analysis of fatigue severity before and after the intervention revealed a reduction post-intervention ($p=0.004$). Additionally, when comparing pre- and post-test daytime sleepiness scores, daytime sleepiness decreased significantly after the intervention (p = 0.020). A moderate effect size was observed in the 6-minute walk test results, whereas levels of fatigue and daytime sleepiness demonstrated small effect sizes (Tables 2 and 3).

Table 2. The comparison of physiological expenditure index, physical activity, fatigue and daytime sleepiness scores for pre and post treatment. Data are presented as median (IQR).

	Pre Treatment Median (IQR) (n=107)	Post Treatment Median (IQR) (n=107)	*Wilcoxon*		
			z	*p*	*d*
PCI	0.28 (0.14–0.38)	0.26 (0.16–0.36)	-0.837	0.402	-0.19
IPAQ	1673 (881–3465)	1386 (863–2706)	-1.784	0.074	-0.27
FSS	4.22 (2.94–5.22)	3.78 (2.89–5.00)	-2.915	0.004*	-0.16
ESS	6 (4–10)	6 (3–8)	-2.327	0.020*	-0.14

PCI physiological cost index, IPAQ international physical activity questionnaire, FSS fatigue severity scale, ESS epworth sleepiness scale,* p<0.05, Wilcoxon Signed Rank Test, d effect size, IQR Interquartile range

Table 3. The comparison of functional capacity for pre and post treatment. Data are presented as mean ± SD

	Pre-Treatment (n=107) Min-Max	Pre-Treatment (n=107) X±SD	Post-Treatment (n=107) Min-Max	Post-Treatment (n=107) X±SD	*Paired T*	*p*	*d*
6MWT (m)	234.00-708.00	496.55±72.46	378.00-672.00	528.78±55.60	-4.850	0.001*	0.50

6MWT 6-minute walk test, m meter * p<0.05, Paired T test, d effect size

DISCUSSION

Our study examined the effects of an 8-week moderate-intensity aerobic and respiratory exercise program on the physiological cost index, physical activity, functional capacity, fatigue, and daytime sleepiness in young adults. Based on our findings, regular aerobic and respiratory exercises performed during the intervention period contributed to increases in functional capacity and reductions in fatigue severity and daytime sleepiness. Although a decrease in the physiological cost index was observed, it was not statistically significant, and no change in physical activity levels was detected. These findings suggest that, while the combined program was effective in improving functional outcomes, certain physiological parameters — such as PCI and physical activity — may require longer intervention durations or more targeted components to produce a measurable change.

A review of the existing literature indicates that studies examining changes in the physiological cost index following exercise interventions are limited. In particular, the effects of prosthetic applications aimed at reducing energy expenditure after amputation on the physiological cost index have been discussed (Hagberg et al., 2011; Sokhangoei et al., 2013). Additionally, although the physiological cost index decreased following gait training in 20 hemiparetic stroke patients, these values remained similar to those of healthy individuals. In our study, although the physiological cost index decreased after moderate-intensity walking exercises incorporated into the regular aerobic training program, the results were comparable to previous findings (Danielsson et al., 2007). One possible explanation for the non-significant change in PCI in our sample is that healthy young adults typically have efficient gait and low baseline energy expenditure, thereby limiting the magnitude of improvement (i.e., a ceiling effect). Furthermore, the indirect influence of respiratory training, although beneficial for ventilatory efficiency, may not be strong enough to independently reduce PCI within an 8-week period.

A study conducted in 2023 investigated the relationship between leg length and the physiological cost index during walking in young adults. The study demonstrated that an increase in leg length reduces energy expenditure, thereby lowering the physiological cost index. In this study, which included 50 participants, the mean body mass index (BMI) was 21.66 ± 1.5 (Gajera & Shah, 2023). In our study, the mean BMI was 23.09 ± 4.17. Although we did not specifically assess leg length, when comparing BMI values, it can be inferred that the relatively shorter height m (1.67 ± 0.08) of participants in our study may have indirectly increased their energy expenditure. Therefore, we propose that the lack of a significant difference in the physiological cost index following the training program may be attributable to this factor. Although a decrease in PCI was observed following the intervention, this change did not reach statistical significance. It is important to interpret this finding cautiously. Previous research suggests that PCI values in healthy young adults are typically low at baseline, which may limit the potential for further improvement due to a ceiling effect. Additionally, factors such as leg length and gait efficiency have been shown to influence energy expenditure during walking; however, because these variables were not directly assessed in the present study, their contributions remain speculative. Therefore, the lack of a significant difference in PCI should be interpreted in light of both the already efficient baseline gait characteristics of the sample and the absence of detailed biomechanical measurements, rather than attributed to a single explanatory factor.

When examining the effects of the aerobic training program on physical activity levels, it was observed that, although levels increased, the post-intervention results did not exhibit significant variability. A randomized controlled trial conducted in 2020 investigated the effects of a 12-week aerobic exercise program on physical activity levels in 43 middle-aged, older adults, and multimorbid individuals. In this study, physical activity levels were assessed using the Chinese short form of the IPAQ, and the results indicated an increase in these levels across all age groups following the intervention (Sarıtoy & Usgu, 2023). Another study evaluated changes in physical activity levels among 254 fitness-center users participating in moderate- and high-intensity aerobic exercise programs, using the IPAQ. Among these participants, 58 engaged in moderate-intensity aerobic training, with 80% undergoing training lasting 1–6 months. Similarly, among individuals participating in high-intensity exercise programs, 75% had training durations of 1–6 months. The study found that individuals engaging in moderate- and high-intensity exercise exhibited similar physical activity levels (Güven & Uğurlu, 2021). In our study, the same assessment tool was used, and post-intervention results were also similar. We speculate that this similarity may be attributed to the nature of the assessment tool, which evaluates individuals' physical activity levels over the past seven days.

Additionally, the high cut-off values of the measurement tool (Flora et al., 2023) suggest that, although the training program may have increased physical activity levels, post-intervention results remained similar. It is also possible that participants' pre-existing activity habits and their young age limited the ability to detect change. Behavioral adaptations generally require longer-term lifestyle modification rather than structured short-term exercise sessions; this requirement may explain the stability of IPAQ scores. Although the categorical distribution of IPAQ levels showed a shift toward the moderate activity category after the intervention, the overall decrease in total IPAQ scores did not reach statistical significance ($p = 0.074$). Therefore, these results should be interpreted cautiously. The apparent discrepancy between the categorical improvement and the reduction in total scores may reflect differences in sensitivity between the scoring and categorical algorithms of the IPAQ, which capture activity patterns differently. Additionally, since the study was conducted during an academic semester, fluctuations in students' weekly activity levels — potentially influenced by coursework intensity, examination periods, and changes in daily routines — may have contributed to the limited ability to detect change. These contextual factors have been highlighted in previous studies, which show that university students often exhibit variable physical activity behavior across the semester. As such, the IPAQ findings in the present study should be interpreted within the behavioral and academic constraints of this population.

Following the 8-week aerobic and respiratory exercise training program administered to healthy young adults, participants showed improvements in functional capacity. Analysis of pre-intervention 6-Minute Walk Test (6MWT) results showed that the mean distance covered was 496.55 ± 72.46 m, increasing to 528.78 ± 55.60 m post-intervention. A review of the literature revealed a lack of studies specifically investigating the effects of aerobic training on functional capacity in healthy individuals. Existing research predominantly focuses on the positive effects of 8- to 12-week aerobic training programs on functional capacity in individuals with orthopedic, neurological, cardiac, or pulmonary conditions. With its large sample size, our study makes a significant contribution to the literature on healthy young adults. In the available literature, one study in stroke patients found that individuals who received an 8-week aerobic exercise program in addition to traditional physiotherapy demonstrated a greater increase in 6MWT distance than that observed in participants who underwent traditional physiotherapy alone (Tang et al., 2009). The inclusion of respiratory training may have enhanced ventilatory efficiency and reduced perceived exertion during walking, thereby contributing to greater improvements in 6MWT performance compared with aerobic exercise alone. This synergistic effect provides a plausible mechanism for the functional gains observed in our sample.

A systematic review of studies conducted in different countries that evaluated healthy individuals reported the average 6MWT distances as follows: Enright et al., 543 ± 71 m; Troosters et al., 534 m; Camarri et al., 536 m; and Iwama et al., 583 m (Troosters et al., 1999; Enright & Sherrill, 1998; Camarri et al., 2006). As shown in these examples, the mean post-exercise distance covered in our study is comparable to, or approaches, these international reference values, underscoring the strength of our findings. Additionally, a study of 102 healthy individuals aged 20 to 50 years reported an average 6MWT distance of 581 m post-test for both male and female participants (Chetta et al., 2006). In a multicenter study evaluating the functional capacity of 272 healthy individuals aged 18 to 50 years, 6MWT distances ranged from 584 m to 686 m, with a mean of 637 m (Halliday et al., 2020). Although our post-intervention values approach these reference ranges for the same age group, our inability to fully reach them may be attributable to the duration of our training program. With our current sample size, which yields a 94% confidence interval, we anticipate that extending the duration of our intervention could allow us to achieve comparable reference values. Furthermore, we believe that such an extension could enhance individuals' awareness of the importance of physical activity, contributing to the development of a more active society. A longer intervention duration may have allowed for more pronounced cardiorespiratory and musculoskeletal adaptations, especially considering that healthy young adults require a higher training threshold to achieve substantial functional improvement.

One of the most critical factors to assess during or after aerobic training is fatigue. High levels of fatigue can reduce exercise motivation and adherence to training programs. However, physical activity is recognized as a key factor in reducing fatigue levels (De Vries et al., 2025). In our study, a decrease in fatigue levels was observed following the aerobic training program. A review of the literature reveals that in a study involving 24 patients with pulmonary arterial hypertension, participants were divided into two groups: one receiving patient education alone and the other undergoing an additional 10-week aerobic exercise program. Individuals who walked on a treadmill at 70–80% of their heart reserve for 30–45 minutes twice a week demonstrated a greater reduction in fatigue levels compared to those who only received patient education (Weinstein et al., 2013). Similarly, another study comparing the effects of an aerobic exercise program and core-stabilization training on fatigue in hemodialysis patients included 39 participants assigned to two groups who underwent an 8-week program. Both interventions significantly reduced fatigue levels (Taşkaya et al., 2024). Additionally, a 12-week Nordic walking exercise program was implemented for 29 individuals who were experiencing Long-COVID symptoms, including fatigue, following the COVID-19 pandemic. The findings indicated that fatigue levels decreased after the aerobic training program (Laguarta-Val et al., 2024). Consistent with previous literature, our study demonstrated a similar reduction in fatigue levels. However, this study is the first to investigate the impact of aerobic exercise on fatigue levels in healthy individuals, independent of underlying medical conditions. The decrease in fatigue may be partly attributable to improved respiratory muscle endurance, which can reduce the perceived effort during daily activities and contribute to an overall reduction in perceived fatigue.

A 2024 systematic review examining the effects of exercise training on daytime sleepiness and sleep quality in healthy individuals reported improvements in daytime sleepiness in four of seven studies that assessed pre- and post-exercise training scores using the Epworth Sleepiness Scale. Additionally, in four of five studies using the Pittsburgh Sleep Quality Index (PSQI) to evaluate sleep quality, post-exercise PSQI scores decreased, indicating improved sleep quality and, indirectly, reduced daytime sleepiness. The related systematic reviews focused on various exercise interventions, including aerobic training, strength training, and flexibility exercises, as well as group-based activities such as Tai Chi and yoga (Sarıtoy & Usgu, 2023; Patel & Cheung, 2024). Consistent with the literature, our study demonstrated a reduction in fatigue levels following an 8-week aerobic and respiratory exercise program. Given its large sample size, we believe that our study will serve as a valuable reference for future systematic reviews in this field. In our study, the decline in daytime sleepiness may reflect improved sleep quality mediated by increased regularity of physical activity and enhanced autonomic balance resulting from aerobic exercise. Respiratory training may further support this outcome by promoting more efficient breathing patterns during sleep, indirectly influencing daytime alertness.

Limitations of the Study

One of the primary limitations of our study is the absence of a control group, as it is a pretest–posttest quasi-experimental study involving a single group. Comparing outcomes of the aerobic training program applied to our healthy participants with those of a control group could have yielded more robust findings. Furthermore, because all participants received both aerobic walking exercises and respiratory training simultaneously, the independent effects of these components cannot be disentangled. As a result, it remains unclear whether the observed improvements were primarily driven by aerobic exercise, respiratory training, or their interaction. Additionally, the cut-off values of the IPAQ-Short Form, which was used to assess physical activity and for which direct counterparts are lacking in the literature, appear relatively high. This may have contributed to the inability to detect a significant difference in post-intervention results. Using an alternative assessment tool might have more clearly demonstrated the increase in physical activity levels. Finally, the behavioral nature of physical activity and the potential influence of academic workload during the semester may have affected participants' weekly routines, reducing the ability to detect changes. Future randomized controlled trials with separate intervention arms and longer follow-up periods are recommended to better clarify these effects.

CONCLUSION

Our study demonstrates that an eight-week, moderate-intensity aerobic exercise program, combined with respiratory exercises designed to enhance its effectiveness, positively affects functional capacity, fatigue, and daytime sleepiness in healthy young adults. Notably, in sedentary populations, structured exercise programs implemented in the absence of underlying pathology are expected to yield beneficial effects on health-related parameters not only in young individuals but also in adults and the elderly. Future studies with a more diverse sample are warranted to further explore these effects. In addition to these findings, the present study highlights the broader societal importance of promoting regular physical activity among young adults, particularly university students, as early adoption of exercise behaviors may contribute to long-term health protection and a reduced risk of chronic diseases. From an academic perspective, the large sample size and combined aerobic–respiratory training protocol offer a valuable reference point for future preventive health-based studies in healthy populations. Clinically, these results suggest that even short-term, structured exercise interventions can produce measurable improvements in functional outcomes and well-being, supporting their potential integration into community health programs, wellness curricula, and preventive physiotherapy applications.

Ethics Committee Approval: Ethical approval was obtained from the Hasan Kalyoncu University Health Sciences Nonivasive Research Ethics Committee with the decision number 2024/23.

Informed Consent: Writtem informed consent were obtained from the participants.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial support: The authors declared that this study has received no financial support.

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