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Effects of Aerobic Exercise and Diaphragmatic Exercise on Cardiovascular Fitness and Quality of Life Among University Students

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ABSTRACT

Background: Aerobic exercise is defined by the American College of Sports Medicine (ACSM) as an activity with a rhythmic component that engages a broad range of muscle groups and can be sustained for an extended period. For instance, walking is an inexpensive, time-efficient aerobic workout that requires little space; it is also an easy form of physical exercise that has been studied more in recent years and has been shown to improve quality of life.

Methods: 30 people participated in the study. In the first week, participants had 15 minutes to complete the WHOQOL-BREF questionnaire. Then, BP and HR were pre-assessed using a blood pressure cuff. Experimental and control groups warmed up for 5 minutes. Intervention participants walked and performed diaphragmatic exercises for 30 minutes, whereas the control group participants walked only for 30 minutes. Static stretching for 5 minutes, cooled down for both groups, for a period of 12 weeks, and 3 times per week.

Results: In the experimental group, pre- and post-exercise SBP, DBP, HR, and Domain 1 (physical health) and Domain 2 (psychological) parameters were significantly different, but Domain 3 (social relationships) and Domain 4 (environment) were not. In the control group, DBP ($p = 0.000$), HR ($p = 0.007$), D1 ($p = 0.004$), and D2 ($p = 0.001$) showed significant pre- to post-exercise differences, whereas SBP, D3, and D4 showed no significant differences.

Conclusion: According to the results of this study, participants demonstrated significant improvements in cardiovascular fitness (BP and HR) and QOL when walking exercise was combined with diaphragmatic exercise, compared with walking exercise alone.

Keywords: aerobic exercise, diaphragmatic exercise, walking exercise, systolic blood pressure, diastolic blood pressure, heart rate, quality of life.

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INTRODUCTION

A person's overall health can be improved by developing cardiovascular fitness through consistent physical exercise (Pescatello, 2014) [1]. In 2016, the World Health Organization (WHO) reported that 28% of persons aged 18 and older did not engage in any form of physical activity, including 23% of men and 32% of women (Guthold et al, 2018) [2]. Aerobic and anaerobic activities are two distinct types of physical exercise. Aerobic exercise is defined by the American College of Sports Medicine (ACSM) as an activity that has a rhythmic component, engages a broad range of muscle groups, and can be sustained for an extended period. Anaerobic exercise is a form of high-intensity physical activity that is not sustained by the body's oxygen supply to the muscles during contraction.

Over the past few years, there has been growing research detailing the positive effects of aerobic exercise on cardiovascular fitness. Aerobic exercise has largely beneficial effects on the circulatory and musculoskeletal systems (Permadi, 2019) [3]. Arazi (2016) suggested that aerobic exercises come in a wide variety and include activities such as walking, running, jogging, and jumping rope, amongst others. Skipping rope is a great way to boost your cardiovascular health and metabolism, as well as work your arm and leg muscles [4]. An experimental study lasting 12 weeks demonstrated that using a jump rope improved cardiovascular fitness (Kirthika et al., 2019) [5]. Another study demonstrated that a jumping rope exercise program was an effective intervention for prehypertensive adolescent girls. This makes sense, given that jumping rope is an exercise that younger people can perform with relative ease (Sung et al, 2019) [6].

Yang et al. (2020) found that having middle school kids participate in freestyle skipping as part of an intervention group led to noteworthy improvements in participants' physical strength and flexibility after 12 weeks [7]. Furthermore, after jumping rope to upbeat music became part of the routine, those in the intervention group showed significant changes in pulmonary function and body mass index within a month. On the contrary, the group serving as the control did not show any signs of alteration in either of the two variables (Seo, 2017) [8].

Walking is a common form of aerobic exercise, and numerous studies have found that it has positive effects on health. Barreira et al. (2010) concluded that young adults in good health would benefit most from engaging in even the most basic form of physical exercise, such as walking at a pace that is comfortable for them [9]. It was shown that older persons who engaged in walking exercise experienced an increase in their aerobic capacity (Haynes et al., 2020) [10].

Despite these findings, there have not been nearly enough quantitative studies on the relationship between aerobic activity and quality of life among university populations. Engaging in physical activity improves quality of life, which in turn affects emotional state, peer connections, level of independence, and degree of social integration (Gill et al., 2013) [11]. As a result, the findings of this study might help college students recognize the benefits of walking and diaphragmatic exercises for cardiovascular fitness and encourage them to try these activities to improve their quality of life. The Abbreviated World Health Organization Quality of Life (WHOQOL–BREF) questionnaire will be utilized to assess quality of life (Skevington et al., 2014) [12]. Therefore, this study aims to determine the extent to which aerobic exercise significantly affects college students' blood pressure, heart rate, and quality of life.

Tan et al. (2022) reported a lack of clarity regarding the benefits of aerobic exercise on cardiovascular fitness and quality of life when performed through brisk walking and diaphragmatic breathing in otherwise healthy young adults. On top of that, there remains a lack of evidence regarding the effects of aerobic and diaphragmatic exercises in healthy younger populations, as previous researchers have mainly focused on children and clinically diagnosed older adults with chronic disease. The stay-at-home orders increased the prevalence of overweight or obesity, BMI, and relative weight gain among Malaysian young adults [13]. The majority of the increase was due to an increase in body weight and BMI among previously underweight or normal-weight individuals. Moreover, according to this study's findings, the majority of students who engage in home-based online education report experiencing various health issues (Mohamad & Yosuf, 2022) [14].

Aerobic exercise is a form of physical activity in which the body's large muscles contract and relax rhythmically over an extended period of time. Aerobic training is also known as cardio or endurance training. Aerobic activities include, but are not limited to, vigorous walking, running, bicycling, swimming, rowing, dancing, and hiking (Garzon, 2017) [15]. Similarly, aerobic means with oxygen present. Aerobic refers to exercises that require oxygen to burn fat for energy. Aerobic exercise employs the same large muscle groups rhythmically for 15 to 20 minutes or longer, while maintaining 60 to 80% of your maximal heart rate (Colzato et al, 2017) [16].

Aerobic exercise, such as supervised walking, has been shown in previous studies to lower both blood pressure and heart rate in elderly populations (Aksović et al, 2020) [17]. Similarly, another study indicates that after 12 weeks of a walking intervention, the heart rate and systolic blood pressure of elderly adults with essential hypertension are markedly reduced (He et al., 2018) [18].

The objective of this study was to evaluate the effects of aerobic exercise and diaphragmatic exercise on systolic and diastolic blood pressure, heart rate, and quality of life among university students, comparing outcomes before and after the interventions. The findings of our study will help university students better understand the benefits of aerobic and diaphragmatic exercises for cardiovascular fitness and overall quality of life. This workout will reduce the risk of developing cardiovascular disease and other morbidities. In addition, it is not only enjoyable but also

quite convenient and inexpensive.

METHODOLOGY

This study was conducted at the University Kuala Lumpur Royal College of Medicine Perak (UniKL RCMP) from August to October 2022. The participants will be asked to complete the Abbreviated World Health Organization Quality of Life Questionnaire (WHOQOL-BREF) at the beginning and end of the study (Krägeloh, 2011) [19]. The participants will be divided into 2 groups by using non-probability, convenience sampling. The intervention group consisted of 15 participants for walking exercise combined with diaphragmatic exercise. The control group consisted of 15 participants for walking exercise only. This procedure will be conducted three times a week for 12 weeks. The participants were chosen based on inclusion and exclusion criteria. The study population consisted of healthy young adults. Prior to the experiment, a consent form was provided to each participant. The participants' age, gender, and body mass index (BMI) will be documented, along with any other relevant demographic information. The inclusion criteria for this study are university students aged 18–28 years with a normal BMI (18.5–24.9). In contrast, the exclusion criteria are students with low BMI (<18.5) and high BMI (>25), clinically diagnosed with any cardiorespiratory diseases, clinically diagnosed with other morbidities, and any recent musculoskeletal injuries.

Sample size

A sample of 30 students is required for this study. The sample size was calculated using G*Power 3.1.9.7. The statistical power analysis with the effect of 0.5, α err prob 0.05, with Power (1 – β err prob) 0.25

Research tools

The participants' pre-assessments were obtained using a blood pressure cuff (model KP-7690) to measure blood pressure (BP) and heart rate (HR), with a reliability of 0.94 (Pescatello et al., 2004) [25]. Reliability and validity coefficients for the WHOQOL-BREF scale domains were greater than 0.70, except for the domain 3, social relationships (0.533). The intra-class correlation coefficients for the four components were significant between 0.491 and 0.769 ($p < 0.001$) (Ili & Šipeti, 2021) [21].

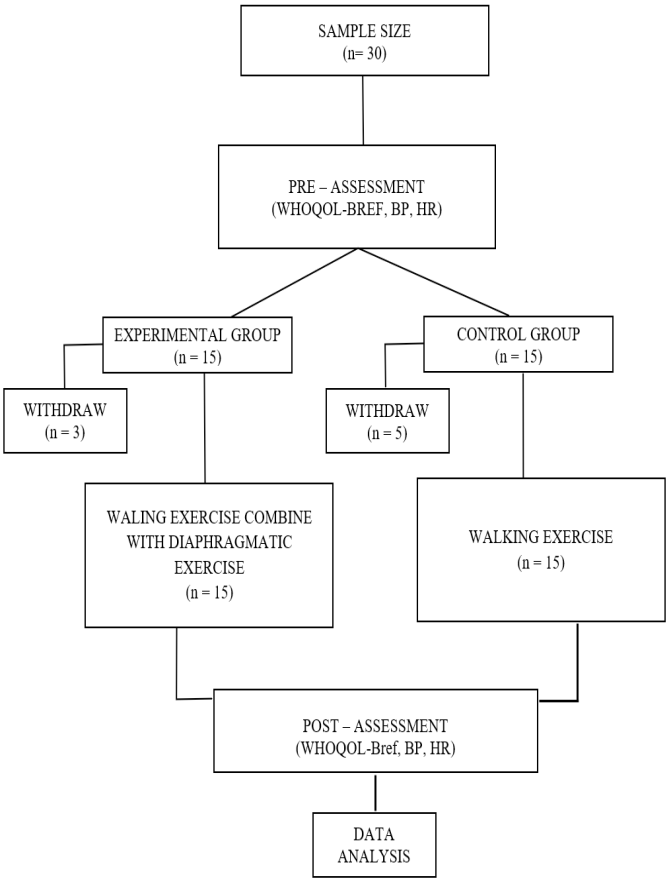
World Health Organization Quality of Life (WHOQOL–BREF) questionnaire, which consisted of four domains: physical health (D1), psychological (D2), social relationships (D3), and environment (D4), and two items on overall QOL and general health. The response options range from 1 (very dissatisfied) to 5 (very satisfied), with higher scores indicating a better quality of life. The scale has seven items for D1, six for D2, three for D3, and eight for D4. Internal consistency for physical health (0.715), psychological health (0.784), social relationships (0.652), and environment (0.8695) [21].

Procedure

The study included 15 participants in the experimental group and 15 in the control group due to participant withdrawals. The flow chart of our study is illustrated in Figure 1. Participants' quality-of-life scores will be measured at the beginning and end of the 12-week intervention sessions. Then, participants' pre-assessments were obtained using a blood pressure cuff to measure blood pressure (BP) and heart rate (HR). Following the evaluation, the experimental and control groups each underwent a 10-minute warm-up session.

Both the intervention and control groups did a 5-minute warm-up. The intervention group performed walking and diaphragmatic exercises for a total of 30 minutes. The control group performed 30 minutes of walking exercise alone. Both groups performed static stretching for 5 minutes as a cool-down. Post-assessments of BP and HR were taken at the 12-week mark of the intervention. The duration of exercises for both groups was 40 minutes. The experiment was carried out for 12 weeks, 3 times per week.

Figure 1: Flow Chart of our study



Data analysis

Collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0. Descriptive analysis was conducted by comparing the means and standard deviations of the experimental and control groups. Inferential analysis was conducted using a paired t-test to determine significant differences between pre- and post-tests for SBP, DBP, HR, and the WHOQOL–BREF questionnaire. P-value was set at 0.05 for this test. The Shapiro-Wilk test was used to assess normality.

RESULTS

Demographic data

The purpose of this study was to determine whether aerobic exercise affects cardiovascular fitness and quality of life. Table 1 shows that 30 participants were involved. The mean age of the participants is 18.09, with the youngest being 18 and the oldest being 19. Meanwhile, for the body mass index (BMI), the minimum BMI was 17.90 and the highest was 24.90, with a mean of 21.61.

Table 1: Demographic data for both groups (n = 22)

Demographic data		N	Minimum	Maximum	Mean
Experiment	Age	15	18.00	19.00	18.0833
	Gender	15	0.00	1.00	0.5833
	Group research	15	0.00	0.00	0.0000
	BMI	15	18.60	24.90	21.7500
Control	Age	15	18.00	19.00	18.1000
	Gender	15	0.00	1.00	0.9000
	Group research	15	1.00	1.00	1.0000
	BMI	15	17.90	24.80	21.4500

BMI – Body mass index

Characteristics of parameters

Table 2 presents the parameter characteristics for both groups. The baseline SBP values were 123.75 ± 11.70 in the experimental group and 124.30 ± 11.62 in the control group. For post SBP in the experimental group (mean = 116.83, SD = 10.74) and the control group (mean = 120.50, SD = 8.22), along with post DBP for the experimental group (mean = 67.67, SD = 11.08) and the control group (mean = 67.20, SD = 8.54), a difference in mean and standard deviation. The baseline characteristics for HR were 88.00 ± 11.26 and 92.20 ± 10.21 for the experimental and control groups, respectively. For the HR parameter, changes in mean and standard deviation were noted post-exercise in the experimental group (mean = 103.42, SD = 11.81) and the control group (mean = 99.40, SD = 9.40). For the quality–of–life WHOQOL–BREF questionnaire, the baseline characteristics for D1 were 67.00 ± 8.56 in the experimental group and 59.00 ± 9.45 in the control group. For the post-experiment, D1 resulted in a significant change in the mean and standard deviation for both the experimental group (mean = 79.75, SD = 0.66) and the control group (mean = 63.90, SD = 9.28). As for D2, the baseline characteristics in the experimental group were 62.17 ± 11.90 and 60.80 ± 12.51. In addition, noted changes for the experimental group (mean = 72.42, SD = 7.63) and the control group (mean = 66.30, SD = 11.09) at post-D2. Baseline characteristics for D3 in the experimental group were 63.58 ± 8.10 and 63.20 ± 9.61. For post D3, there was also a difference for the experimental group (mean = 64.58, SD = 9.10). Lastly, the baseline characteristics for D4 were 63.67 ± 10.60 and 66.40 ± 8.10 for the control group. For post D4, noted an increasing value in mean and standard deviation experiment (mean = 66.67, SD = 9.40) and control (mean = 67.00, SD = 7.82).

Table 2: Characteristics of parameters between the groups

Group	Mean ± SD													
	Pre SBP	Post SBP	Pre DBP	Post DBP	Pre HR	Post HR	Pre D1	Post D1	Pre D2	Post D2	Pre D3	Post D3	Pre D4	Post D4
Experimental	123.75± 11.70	116.83± 10.74	82.08± 10.83	67.67± 11.08	88.00± 11.26	103.42± 11.81	67.00± 8.56	79.75± 6.66	62.17± 11.90	72.42± 7.63	63.58± 8.10	64.58± 9.10	63.67± 10.60	66.67± 9.40
Control	124.30± 11.62	120.50± 8.22	79.40± 9.26	67.20± 8.54	92.20± 10.21	99.40± 9.40	59.00± 9.45	63.90± 9.28	60.80± 12.51	66.30± 11.09	63.20± 9.61	64.40± 8.10	66.40± 8.10	67.00± 7.82

Values are reported as the Mean ± SD, $p < 0.05$ within group.

SBP – systolic blood pressure, DBP – diastolic blood pressure, HR – heart rate, D1 – Domain 1 (Physical health), D2 – Domain 2 (Psychological), D3 – Domain 3 (Social relationships), D4 – Domain 4 (Environment)

Comparison of parameters in the experimental group

Table 3: Comparison of parameters pre- and post among the experimental group

Parameters	t value	P value
SBP	3.455	0.005*
DBP	4.200	0.001*
HR	-3.333	0.007*
D1	-8.186	0.000*
D2	-6.292	0.000*
D3	-1.483	0.166
D4	-2.171	0.053

A paired t-test was used to compare data from both groups and determine whether there was a significant difference between the scores before and after the test ($p < 0.05$). Results showed a significant difference between pre- and post-exercise in the experimental group for SBP ($p = 0.005$), DBP ($p = 0.001$), HR ($p = 0.007$), D1 ($p = 0.000$), and D2 ($p = 0.000$). At the same time, there was no significant difference for D3 ($p = 0.166$) and D4 ($p = 0.053$) parameters. The results were tabulated in Table 3. The results indicate that aerobic exercise, such as walking, combined with diaphragmatic exercise, decreases SBP, DBP, and HR, thereby improving cardiovascular outcomes. For the quality-of-life aspect, the D3 and D4 domains did not show higher scores, whereas D1 and D2 resulted in higher scores, corresponding to a greater perceived quality of life.

* $p < 0.05$ statistically significant difference, paired t-test

Comparison of parameters in the control group

The findings indicated a statistically significant variation ($p < 0.05$) between pre-exercise and post-exercise in the control group for DBP ($p = 0.000$), HR ($p = 0.007$), D1 ($p = 0.004$), D2 ($p= 0.001$) parameters meanwhile no significant difference for SBP ($p = 0.419$), D3 ($p = 0.166$) and D4 ($p = 0.343$) parameters. The results were tabulated in Table

4. The results demonstrated that walking exercise only decreases DBP and HR in the cardiovascular aspect. As for quality of life, only the D1 and D2 domains showed higher scores, indicating a greater perceived quality of life.

Table 4: Comparison of parameters pre and post among the control group

Parameters	t value	P value
SBP	0.847	0.419
DBP	4.200	0.000*
HR	-3.857	0.007*
D1	-3.862	0.004*
D2	-5.056	0.001*
D3	0.610	0.168
D4	0.757	0.343

* $p < 0.05$ statistically significant difference, paired t-test

DISCUSSION

Our study further strengthens the growing body of evidence supporting the beneficial role of aerobic exercise. It highlights its effectiveness in improving cardiovascular fitness and quality of life (QOL) among university students. Regular participation in structured aerobic exercise induces multiple physiological adaptations. These changes occur particularly within the cardiovascular and respiratory systems. Together, they contribute to improved functional capacity and overall health outcomes. These adaptations include improvement in stroke volume. They also involve improved cardiac output efficiency. Additionally, there is a reduction in peripheral vascular resistance. Improved oxygen utilization by skeletal muscles is another important adaptation (McArdle et al., 2010; Warburton et al., 2006) [22,23].

One of the key findings of our study is a significant reduction in systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) in the experimental group after 12 weeks of intervention. These findings are similar to previous studies demonstrating that aerobic exercise plays a critical role in modulating autonomic balance by increasing parasympathetic activity and reducing sympathetic tone, thereby improving cardiovascular efficiency (Cornelissen & Fagard, 2005; Pescatello et al., 2004) [24,25]. Improved cardiac conditioning is also indicated by a decrease in resting heart rate, suggesting that the heart becomes more effective at pumping blood with fewer beats per minute (Fagard, 2003) [26]. The purpose of this study is to examine whether aerobic exercise affects cardiovascular fitness and quality of life among university populations.

In contrast, the control group did not demonstrate significant improvements in SBP. This finding suggested that low-intensity physical activity alone may not be sufficient to improve cardiovascular adaptations within a relatively short duration, such as 12 weeks. Although walking is widely recognized as a beneficial and inexpensive form of physical activity, its effectiveness largely depends on factors such as intensity, duration, and frequency (Lee et al., 2012) [27]. These findings align with earlier research indicating that moderate-to-vigorous-intensity aerobic exercise significantly improves cardiovascular fitness compared with low-intensity activities (Garber et al., 2011) [28].

The findings of this study indicate that after 12 weeks of intervention, the SBP, DBP, and HR of the experimental group are significantly reduced ($p < 0.05$) compared with those in the control group. In the meantime, the control group did not demonstrate any significant changes in their SBP ($p > 0.05$). Based on these findings, the cardiovascular and respiratory systems appear to experience relatively low demand when walking is the sole form of exercise in the control group. This supports the current study's hypothesis that there will be no substantial difference in participants' blood pressure when they are merely put through a walking exercise. In contrast, another study demonstrates that older people's aerobic capacity can be improved by 24 weeks of walking exercise (Skevington et al, 2014) [29].

Aerobic exercise contributes a positive impact on cardiovascular fitness and QOL. Related literature has discussed the effectiveness of aerobic exercise on students' cardiovascular fitness, which is the targeted population in the current study (Alemayehu et al., 2020; Choudhary et al., 2015; Shokri et al., 2022) [30,31,32]. Meanwhile, further discussion was conducted on how aerobic exercise has influenced the students' QOL (Lu, 2022; Ugwueze et al, 2021) [33,34].

Haynes et al. (2019) stated that jumping rope has been proven to have positive effects on both the cardiovascular and pulmonary systems [35]. In addition, the present findings appear consistent with prior research, which revealed that improving cardiovascular endurance through walking and diaphragmatic exercises over 12 weeks is both safe and effective. Therefore, the results of the current study support the claim that there is a substantial difference in subjects' blood pressure when they were subjected to a combination of walking and diaphragmatic exercises, as opposed to walking exercise on its own. For the physiologic response post-aerobic exercise, arterial blood pressure at rest will result in a subtle reduction in normotensive populations. This is evidenced by the current study's finding that both the experimental and control groups reported decreases in mean diastolic blood pressure (DBP) with $p < 0.05$.

Domain 1 results show a significant difference between the exercise and control groups after the exercise. The current findings appear comparable to those of a prior study, which found that a physically inactive or insufficiently active lifestyle was associated with worse scores on the health-related quality of life (HRQOL) scale (Orhan, 2013) [36]. There are similarities between the perspectives in which higher levels of physical activity were associated with enhanced quality-adjusted life-years (QALY) outcomes, with a strong, graded correlation (Buder et al., 2016) [37].

Furthermore, the association between physical activity and quality-adjusted life years (QALYs) has been well documented, with higher levels of physical activity associated with better health outcomes and longevity

(Brown et al., 2014) [38]. The current findings support this, suggesting that even short-term aerobic exercise improved QOL among young adults. This is particularly important in the university setting, where students often experience high levels of stress, sedentary behavior, and irregular lifestyle patterns.

Reduction in DBP observed in both the experimental and control groups is another important finding of this study. This suggests that low-intensity exercises, such as walking, may have beneficial effects on cardiovascular function. Aerobic exercise is known to improve endothelial function and promote vasodilation by increasing nitric oxide production, thereby reducing blood pressure (Green et al., 2017) [39]. However, the greater improvements in the experimental group highlight the importance of combining aerobic and diaphragmatic exercises.

Moreover, gender differences may influence the effects of aerobic exercise. Joiner (2017) indicated that males and females may exhibit different cardiovascular and hormonal adaptations to exercise due to variations in body composition, hormonal profiles, and baseline fitness levels [40]. Although our study did not specifically analyze gender-based differences, exploring such variations will provide valuable insights for personalized exercise prescriptions for younger adults.

There were no statistically significant differences in Domain 3 levels between the experimental and control groups. This finding contrasts with evidence indicating that social engagement is a significant factor in improving one's quality of life (Sun et al., 2014) [41]. On the other hand, the participants in the prior study were older adults, whereas the present study's participants were younger.

Although a significant difference was found for the D1 and D2 domains, the D3 and D4 scores did not differ significantly between the experimental and control groups.

Additionally, the use of subjective measures to assess quality of life may introduce bias, as personal perceptions can influence participants' responses. Prince et al. (2008) suggested that combining objective assessments, such as physical performance tests, with subjective assessments enhances reliability [42].

CONCLUSION

The present study concludes that aerobic exercise combined with diaphragmatic breathing significantly improves cardiovascular fitness and quality of life among students. Participants in the experimental group showed greater reductions in systolic and diastolic blood pressure and heart rate compared to those who performed walking exercise alone. Significant improvements were also observed in all domains of quality of life, particularly in physical and psychological health.

Limitation

Despite its strengths, our study has some limitations. The relatively short duration of the intervention and the specific demographic may limit the generalizability of the findings. Additionally, factors such as dietary habits, stress levels, and sleep patterns, which can influence cardiovascular health and QOL, were not included in our study. Future research should aim to address these variables and the long-term effects of combined aerobic and diaphragmatic exercises.

The current research has several limitations, one of which is its rather small sample size. Using a larger sample size is strongly encouraged to reduce the likelihood of bias in this experiment. Furthermore, future research may focus on long-term follow-ups to investigate whether participants in both groups sustain their improvements over time. Lastly, since the environmental setting in which this research was conducted was less conducive, it is strongly suggested that it should be carried out in a more extensive, specific area.

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