นิพนธ์ต้นฉบับ . Original Article

ผลของการฝึกหายใจร่วมกับการออกกำลังกายแบบแอโรบิกต่อสมรรถภาพทางกายและคุณภาพชีวิตในผู้ป่วยโรคหืด

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The Effects of Breathing and Aerobic Exercises on Physical Fitness and Quality of Life in Patients with Asthma

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บทคัดย่อ

<u>หลักการและวัตถุประสงค์:</u> การฝึกหายใจและการออกกำลังกายแบบแอโรบิกมีประโยชน์ต่อผู้ป่วยโรคหืด อย่างไรก็ตามการศึกษาเกี่ยวกับการผสมผสานการออกกำลังกายทั้งสองรูปแบบยังมีจำกัด ดังนั้นการศึกษานี้จึงศึกษาผลของการฝึกหายใจร่วมกับออกกำลังกายแบบแอโรบิกต่อสมรรถภาพทางกาย และคุณภาพชีวิตในผู้ป่วยโรคหืด

<u>วิธีการศึกษา:</u> การศึกษานี้เป็นการศึกษาเชิงทดลองแบบสุ่มที่มีกลุ่มควบคุมแบบปกปิดฝ่ายเดียว อาสาสมัครจำนวน 30 ราย ได้รับการสุ่มเข้าโปรแกรม 2 กลุ่ม ได้แก่ กลุ่มควบคุม และกลุ่มทดลองในอัตรา 1:1 อาสาสมัครในกลุ่มควบคุมออกกำลังกายแบบแอโรบิก ส่วนอาสาสมัครในกลุ่มทดลองออกกำลังกายแบบแอโรบิกร่วมกับการฝึกหายใจ โดยอาสาสมัครทั้งสองกลุ่มออกกำลังกาย 50 นาทีต่อครั้ง 3 ครั้งต่อสัปดาห์ เป็นระยะเวลา 12 สัปดาห์ ตัวแปรในการประเมินสมรรถภาพทางกาย ได้แก่ การทรงตัวแบบคงที่ (การทดสอบการทรงตัวขณะอยู่นิ่งโดยการยืนขาเดียว) การทรงตัวแบบเคลื่อนไหว (การทดสอบการทรงตัวขณะเดิน) และความแข็งแรงของกล้ามเนื้อขา (การทดสอบกำลังกล้ามเนื้อขาโดยการลุกนั่ง 5 ครั้ง) รวมถึงการประเมินคุณภาพชีวิต (แบบประเมินคุณภาพชีวิตสำหรับผู้ป่วยโรคหืดด้วย mini-AQLQ) ก่อนฝึก ระหว่างฝึกที่ 6 สัปดาห์ และ หลังฝึกที่ 12 สัปดาห์

<u>ผลการศึกษา</u>: การออกกำลังกายทั้งสองโปรแกรมเป็นเวลา 6 และ 12 สัปดาห์ สามารถเพิ่มสมดุลการทรงตัวทั้งแบบคงที่และแบบเคลื่อนไหว ความแข็งแรงของกล้ามเนื้อขา และคุณภาพชีวิต อย่างมีนัยสำคัญทางสถิติเมื่อเทียบกับก่อนฝึก ($p < 0.05$) สิ่งที่น่าสนใจคือการฝึกหายใจร่วมกับการออกกำลังกายแบบแอโรบิกสามารถเพิ่มการทรงตัวแบบคงที่และแบบเคลื่อนไหว ความแข็งแรงของกล้ามเนื้อขา และคุณภาพชีวิตได้มากกว่าการออกกำลังกายแบบแอโรบิกเพียงอย่างเดียวที่ 12 สัปดาห์ ($p < 0.05$)

<u>สรุป:</u> การผสมผสานการฝึกหายใจและออกกำลังกายแบบแอโรบิกสามารถเพิ่มสมรรถภาพทางกายและคุณภาพชีวิตในผู้ป่วยโรคหืดได้

คำสำคัญ: การออกกำลังกายแบบแอโรบิก, โรคหืด, การฝึกหายใจ, สมรรถภาพทางกาย, การฟื้นฟูปอด

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Abstract

Background and Objective: Breathing and aerobic exercises are known to be beneficial for patients with asthma. However, research on combining these exercises is limited. Therefore, this study investigated the effects of a combining breathing with aerobic exercise on physical fitness and quality of life in asthmatic patients.

Methods: This study was a single-blind, randomized controlled trial. Thirty patients with asthma were randomly allocated to either a control group (CG) or a training group (TG) in 1:1 ratio. Participants in the CG performed aerobic exercise only, whereas those in the TG participated in both aerobic exercise and breathing exercise program. Both groups exercised for 50 minutes per session, 3 times per week, for a duration of 12 weeks. Physical fitness parameters including static balance (one leg stand test; OLST), dynamic balance (time up and go test; TUGT), and lower limb strength (five-time sit to stand test; FTSST), along with quality of life (mini asthma quality of life questionnaire; mini-AQLQ) were evaluated at baseline, mid-intervention (6 weeks), and post-intervention (12 weeks).

Results: Both exercise interventions significantly increased OLST, TUGT, FTSST, and mini-AQLQ scores at both 6 and 12 weeks of the study period when compared with baseline ($p < 0.05$). Interestingly, the TG showed significantly greater improvements in OLST, TUGT, FTSST, and mini-AQLQ (total scores and symptom domain) compared to the CG at 12 weeks ($p < 0.05$).

Conclusions: These results suggest that the combination of breathing and aerobic exercises effectively improve physical fitness and quality of life in asthmatic patients.

Keywords: aerobic exercise, asthma, breathing exercise, physical fitness, pulmonary rehabilitation

Introduction

As one of the most widespread chronic respiratory diseases, asthma affects people of all ages, and its prevalence is significantly increasing worldwide. The inflammatory nature of asthma causes recurring symptoms like wheezing, dyspnea, chest tightness, and coughing, which fluctuate in occurrence, frequency, and intensity[1]. These symptoms frequently discourage exercise participation due to concerns about exacerbations. This avoidance behavior can result in a sedentary lifestyle and subsequent negative health outcomes, including heightened fatigue, decreased daily activity, and reduced physical fitness[2]. Ultimately, this can contribute to inadequate asthma control and a poor quality of life[3].

Pulmonary rehabilitation, non-pharmacological treatment, is well-established, with exercise training being a key component. Evidence from systematic reviews suggests that aerobic exercise training can enhance physical performance, decrease the likelihood of asthma exacerbations, and improve exercise capacity and pulmonary function[4,5]. These improvements hold the potential to facilitate better asthma management and enhance overall quality of life.

Moreover, breathing exercise commonly appear as an educational component of pulmonary rehabilitation program to help asthmatic patients achieve better breathing patterns with longer exhalations and lower respiratory rates, thus reducing hyperventilation and hyperinflation[6]. Breathing exercise has also been found to improve pulmonary function, hyperventilation symptoms, asthma control and quality of life in asthmatic patients[7].

A previous study revealed that aerobic exercise and breathing exercise programs presented similar results in asthma control, quality of life, asthma symptoms, physical activity, and airway inflammation[8]. Nevertheless, research specifically examining the effectiveness of a combined exercise program for individuals with asthma remains limited. Therefore, the aim of present study was to investigate the effects of an exercise intervention incorporating both aerobic and breathing exercises on physical fitness, as measured by balance and lower limb muscle strength, and on quality of life, as assessed by an asthma quality of life questionnaire (AQLQ), in asthmatic patients. We hypothesized that the effect of combined breathing and aerobic exercise approach would increase in physical fitness and improve quality of life among individuals with asthma.

Methods

Study design

A single-blind, randomized controlled trial was conducted following ethical approval from the Khon Kaen University Ethics Committee for Human Research (HE651440) and prospective registration with the Thai Clinical Trials Registry (TCTR20230913002). Participants were recruited from Srinagarind and Nong Ruea Hospitals in Thailand, and all provided written informed consent prior to enrollment. Following baseline assessments, they were randomly allocated to either the control group (CG) or the training group (TG) using a computer-generated randomization sequence with unique identifiers in a 1:1 ratio. Participants in the CG engaged in aerobic exercise alone, while those in the TG commenced a combined aerobic and breathing exercise program.

Study population

Individuals diagnosed with asthma according to the global Initiative for asthma guidelines (GINA)[1] were recruited. Eligible participants were adults aged 20-65 years who were not engaging in any other exercise program and who maintained stable asthma medication. Exclusion criteria included other respiratory diseases (e.g., chronic obstructive pulmonary disease, infections), asthma exacerbation within the prior month, cardiovascular conditions (e.g., heart failure, ischemic chest pain), physical limitations affecting the ability to exercise, and pregnancy.

Sample size calculation

The sample size was calculated based on the change in total score of AQLQ between the two groups after breathing exercise in asthmatic patients[9]. A sample size was calculated to be 12 participants per group with a power of 80% and a significance level of 5%. To accommodate the approximately 20% drop out rate, the sample size was increased to 15 subjects per group.

Randomization and blinding

Following informed consent, participants were randomly assigned in a 1:1 ratio to either the CG or the TG using computer-generated simple randomization, with allocation concealment implemented as follows. Opaque, sequentially numbered envelopes was prepared by the researcher. Each envelope contained a slip of paper indicating group allocation arranged according to the randomization sequence generated by https://www.randomizer.org/. The envelopes were then be sealed to prevent disclosure. A research assistant invited each participant to select one envelope, and the researcher subsequently informed the participant of their group assignment based on the letter inside the envelope. An outcome assessor was blinded to both the clinical context and group allocation of each participant.

Physical fitness measurements

(1) *One leg stand test (OLST).* To assess static balance control, the OLST was administered. Participants were instructed to stand on one leg with their eyes open, ensuring the non-supporting leg did not contact the stance limb, and to maintain this stance for the longest possible duration. Three trials were conducted for each leg, and the maximum holding time was used for analysis[10].

(2) *Time up and go test (TUGT).* To evaluate dynamic balance control, the TUGT was administered. Participants were instructed to stand from a standard chair (around 46 cm seat height) without using their hands, walk around a cone placed 3 meters away, and return to sit down at a comfortable and safe pace. The time from standing up to sitting down was recorded, and the average of three trials was used for analysis[11].

(3) *Five times sit to stand test (FTSST).* This test measures lower limb muscle strength and serves as a reliable assessment of functional outcome in individuals with asthma undergoing pulmonary rehabilitation. Participants were instructed to complete five consecutive sit-to-stand cycles as quickly as possible from a standard chair (approximately 46 cm high) with their arms crossed and without using the chair back for support. The time taken from the “Go” signal until the final sit was recorded, and the average of three trials was calculated[12].

Asthma-related quality of life

The quality of life of asthmatic patients was assessed using the mini asthma quality of life questionnaire (mini-AQLQ), a 15-item instrument evaluating four domains: symptom, activity, emotional well-being, and environmental factors[13]. The questionnaire utilizes a seven-point rating scale for each item (1 = a great deal, 7 = not at all). On this scale, 7 indicates no impairment, and 1 indicates maximum impairment. For individual items, A change of 0.5 is the minimal clinically important difference (MCID) while changes of 1.0 and >1.5 represent moderate and large differences, respectively[14].

Procedure of exercise intervention

The 12-week exercise intervention involved 36 sessions (3 times weekly). The intervention for the TG in each session consisted of a 5-minute warm-up, a 30-minute aerobic exercise period, a 10-minute breathing exercise (including 5 minutes of pursed-lip breathing and 5 minutes of diaphragmatic breathing), and a 5-minute cool-down, for a total duration of 50 minutes. The intervention for the CG in each session consisted of a 5-minute warm-up, a 40-minute aerobic exercise period, and a 5-minute cool-down, also totaling 50 minutes. Aerobic exercise intensity of both groups was maintained at 55-70% of the participants' maximal heart rate (HRmax)[15], with heart rate monitor using the Polar RS800CX (Polar Electro Oy, Finland). The researchers developed this low-impact program, guided by the ACSM's 2012 recommendations for group exercise and adapted for individuals with asthma, utilizing a 4-inch step and a tempo of 120-130 bpm[16]. The aerobic exercise comprised 10 movements on a bench (v-step, basic in-out, tap up, side tap, knee up, over the top, turn step, cross back, across the top chasse, and indecision), each performed 10 times. All sessions were conducted under the direct supervision of a qualified physiotherapist with five years of professional experience. Adherence to the intervention was defined as completing 29 or more of the scheduled sessions.

Statistical analysis

The normality of the data was assessed using Shapiro-Wilk test. Means and standard deviations (SD) summarize the descriptive statistics. Independent t-tests compared differences between groups, and repeated measures ANOVA assessed within-group changes across the baseline, 6-week, and 12-week time points to evaluate the intervention's effect. Statistical significance was set at $p < 0.05$. IBM SPSS version 20 was used for all statistical computations, and GraphPad Prism 9 facilitated data visualization.

Results

Baseline characteristics of both groups are shown in Table 1. The CG and the TG displayed no significant difference in age, height, weight, BMI, FEV_1, mini-AQLQ when compared between groups. Of the 30 patients with asthma who were recruited for this study, one patient dropped out due to COVID-19 infection and incomplete exercise program; therefore 29 subjects completed the study.

Effect of breathing and aerobic exercise program on physical fitness

The results for physical fitness are illustrated in Figure 1. Comparison within-group in the CG, the results demonstrated a significant improvement in static balance, as indicated by OLST at 6 and 12 weeks (from 54.76 ± 8.48 seconds at baseline to 76.89 ± 9.74 seconds at 6 weeks, and to 100.55 ± 3.70 seconds at 12 weeks, $p < 0.001$). Furthermore, the CG showed a significant improvement in dynamic balance, as indicated by TUGT (from 9.22 ± 0.71 seconds at baseline to 7.80 ± 0.53 seconds at 6 weeks, and to 7.04 ± 0.55 seconds at 12 weeks, $p < 0.001$). Moreover, the CG showed a significant improvement in lower limb muscle strength, as indicated by FTSST (from 10.41 ± 0.88 seconds at baseline to 9.16 ± 0.91 seconds at 6 weeks, and to 7.10 ± 0.75 seconds at 12 weeks, $p < 0.001$).

For within-group comparison in the TG, the results demonstrated a significant improvement in OLST at 6 and 12 weeks (from 58.18 ± 6.85 seconds at baseline to 74.70 ± 7.14 seconds at 6 weeks, and to 115.33 ± 4.95 seconds at 12 weeks, $p < 0.001$). Furthermore, the TG showed a significant improvement in TUGT (from 9.27 ± 1.11 seconds at baseline to 7.07 ± 0.79 seconds at 6 weeks, and to 5.05 ± 0.87 seconds at 12 weeks, $p < 0.001$). Moreover, the TG showed a significant improvement in FTSST (from 10.64 ± 0.92 seconds at baseline to 8.85 ± 0.89 seconds at 6 weeks, and to 5.85 ± 0.37 seconds at 12 weeks, $p < 0.001$).

In the comparison between groups, the TG showed significantly greater improvement in TUGT ($p < 0.001$), OLST ($p < 0.001$), and FTSST ($p < 0.05$) compared to the CG at 12 weeks.

Effect of breathing and aerobic exercise program on quality of life

The mini-AQLQ scores for each group are presented in Table 2. In the within-group comparison, both CG and TG showed significant improvements in the total mini-AQLQ score, as well as in the symptom domain score, activity domain score, and environmental domain score at both 6 and 12 weeks of the study period ($p < 0.05$). Notably, comparison between groups, the TG demonstrated significantly greater improvements in the total score and symptom domain score compared to the CG at 12 weeks ($p < 0.001$ and $p = 0.003$, respectively). In contrast, improvements in the activity, emotional, and environmental domains were not significantly different between the two groups.

Discussion

The findings of this study demonstrated statistically significant improvements in physical fitness and in the total, symptom, activity, and environmental domain scores of asthma-related quality of life in both groups. Notably, the group engaging in both breathing and aerobic exercise training exhibited more substantial improvements in physical fitness and in total scores and symptom domain scores of asthma-related quality of life compared to participants who underwent aerobic exercise training alone.

This study provides evidence that asthmatic patients who performed aerobic exercise alone or a combination of aerobic and breathing exercises can improve dynamic balance (TUGT), static balance (OLST), and lower limb strength (FTSST) because of their engagement in aerobic exercise on a bench within the exercise program. These results are consistent with a previous study that found 8 weeks of aerobic exercise on a bench improves balance and lower limb strength in elderly women[17]. The enhanced performance in lower limb strength could be attributed to a mechanism involving nervous system and muscle stimulation, followed by eccentric and concentric contractions. The rapid nature of these contractions may promote the activation of motor units, specifically fast-twitch muscle fibers, leading to increased muscle contraction speed and power output[18,19]. Moreover, executing stepping movements in multiple directions necessitates ongoing regulation of the body's center of gravity to facilitate accurate and smooth movement, potentially improving balance.

Remarkably, the incorporation of breathing and aerobic exercise training led to a significantly greater increase in balance and lower limb strength compared to aerobic exercise alone, which aligns with the objective of this study. This finding is consistent with prior research showing that diaphragmatic breathing exercise effectively improves balance in healthy individuals[20]. Respiratory muscles influence respiratory function and also play a role in controlling balance. Diaphragmatic breathing enhances the activity of core muscles, including those in the trunk, diaphragm, and abdomen, leading to elevated intra-abdominal pressure, which subsequently increases lumbar stiffness[21]. Moreover, prior research indicates that breathing exercise or respiratory muscle training improves diaphragmatic and low back proprioception, trunk control, trunk activity, and respiratory strength[22-24]. Therefore, the implemented breathing exercises and the consequent increase in diaphragmatic breathing may have augmented the strength of both the diaphragm and the deep core musculature. This improvement in strength and proprioception, in turn, may have contributed to the observed gain in balance. Furthermore, the contraction of the diaphragm stimulates the respiratory region of the primary motor cortex, which is adjacent to the areas controlling limb musculature. This proximity may facilitate enhanced recruitment of limb muscles, potentially resulting in improved motor performance, such as greater coordination and strength[25]. Based on the aforementioned evidence, breathing exercise combined with aerobic exercise are more effective in improving balance and lower limb muscle strength, than aerobic exercise alone.

The present study demonstrated that the both implemented aerobic exercise programs led to notable improvements in quality of life, as evidenced by increased scores on the mini-AQLQ that exceed the MCID (> 0.5 points) in both groups. Interestingly, a combination of breathing and aerobic exercises led to significantly greater improvement in mini-AQLQ, especially in total and symptom domain scores, when compared with aerobic exercise alone, thus achieving the aim of this research. Our results are consistent with previous research showing that aerobic exercise programs improve quality of life in asthmatic patients, as indicated by clinically significant increases in AQLQ scores after a 12-week treadmill-based program[26,27]. Similarly, another previous study observed a significant improvement in quality of life, as measured by mini-AQLQ, following a 12-week aerobic intervention, with a clinically significant change of more than 0.5 points[28].

A prior study showed that six months of diaphragmatic breathing exercises led to a notable improvement in AQLQ scores among individuals with asthma[29]. Diaphragmatic breathing is a technique characterized by slow and deep breathing that reduces respiratory rate and increases tidal volume, thus enhancing the efficiency of ventilation for gas exchange through alveolar expansion, improving alveolar ventilation, and increasing arterial oxygen saturation[30]. Furthermore, an eight-week program of diaphragmatic breathing has been shown to reduce dyspnea and enhance physical activity[31], which may contribute to improved quality of life. Pursed-lip breathing is a type of breathing exercise in which air is slowly inhaled through the nose and then exhaled slowly through pursed lips. This technique helps to expel more air from the lungs, thereby improving gas exchange[32]. A previous study demonstrated that pursed-lip breathing alleviates dyspnea, possibly by increasing positive expiratory pressure during expiration, which subsequently decreases airway narrowing and reduces hyperinflation[33]. Therefore, diaphragmatic and pursed-lip breathing have a potential to improve gas exchange, decrease the energy expenditure of breathing, and alleviate dyspnea[34,35], leading to improve quality of life.

Aerobic exercise enhances balance and lower limb muscle strength, which can improve the ability to perform various activities. This, in turn, positively impacts the activity domain of asthma-related quality of life. Additionally, breathing exercises help reduce dyspnea, thereby improving the symptom domain of asthma-related quality of life. As a result, combining breathing exercise with aerobic exercise produces greater improvements in the total quality of life scores in asthmatic patients compared to aerobic exercise alone. Further studies should investigate the underlying mechanisms of the combined exercise program, specifically its effects on airway inflammation, inflammatory cytokines, oxidative stress, as well as their impact on muscle function, lung function, and symptoms in patients with asthma. This approach would help clarify the pathways through which the intervention enhances asthma outcomes and physical performance.

There were likewise some limitations in this study. First, the sample size was relatively small, which may limit the generalizability of the findings to the broader asthma population. A larger cohort would be necessary to confirm the observed effects and to assess the impact of combined interventions. Second, the long-term sustainability of the effects of the training program after the intervention period was not assessed. As a result, it is unclear whether the observed benefits persist once training has concluded, highlighting the need for future studies incorporating longer follow-up periods. Finally, individual differences in daily physical activity were not controlled which could act as potential confounders.

Table 1 Baseline characteristics of the participants.

Variables	CG (n = 15)	TG (n = 14)	p-value
Age (yr)	45.08 ± 10.65	47.71 ± 13.62	0.620
Gender (male/female)	4/11	4/10	0.617
Weight (kg)	65.15 ± 8.65	63.87 ±14.57	0.088
Height (m)	1.60 ± 0.06	1.58 ± 0.10	0.337
BMI ($kg{\cdot}m^{-2}$)	25.42 ± 2.68	25.74 ± 3.80	0.359
FEV_1 (% predicted)	84.15 ± 12.25	81.64 ± 15.75	0.325
FEV_1 (l)	2.05 ± 0.35	2.13 ± 0.47	0.503
FVC (% predicted)	93.07 ± 13.14	97.78 ± 8.97	0.278
FVC (l)	2.98 ± 0.94	2.81 ± 0.59	0.582
FEV_1/FVC	76.65 ± 10.00	72.00 ± 6.60	0.940
The mini-AQLQ (score)			
Total score	4.67 ± 0.81	4.83 ± 0.61	0.467
Symptom domain	4.37 ± 0.46	4.31 ± 0.64	0.789
Activity domain	5.61 ± 0.81	6.03 ± 0.91	0.300
Emotional domain	5.12 ± 0.96	5.19 ± 0.36	0.876
Environmental domain	4.02 ± 1.00	3.90 ± 0.21	0.772

Data are presented as mean ± SD. Abbreviations: CG = control group; TG = training group; BMI = body mass index; FEV_1 = forced expiratory volume in the first second; FVC = forced vital capacity; mini-AQLQ = the mini–asthma quality of life questionnaire.

Table 2 Outcomes of asthma-related quality of life in all experimental groups.

Outcomes	Week 0		Week 6		Week 12	
	CG (n = 15)	TG (n = 14)	CG (n = 15)	TG (n = 14)	CG (n = 15)	TG (n = 14)
mini-AQLQ, score						
Total score	4.67 ± 0.81	4.83 ± 0.61	5.46 ± 0.31 #	5.72 ± 0.62 #	6.16 ± 0.55 #†	6.77 ± 0.29 *#†
Symptom domain	4.37 ± 0.46	4.31 ± 0.64	5.23 ± 0.36 #	5.51 ± 0.59 #	6.35 ± 0.47 #†	6.81 ± 0.24 *#†
Activity domain	5.61 ± 0.81	6.03 ± 0.91	6.43 ± 0.57 #	6.73 ± 0.50 #	6.77 ± 0.40 #	6.96 ± 0.63 #
Emotional domain	5.12 ± 0.96	5.19 ± 0.36	5.55 ± 1.16	5.53 ± 0.78	5.65 ± 1.11	5.86 ± 0.80
Environmental domain	4.02 ± 1.00	3.90 ± 0.21	4.80 ± 1.37 #	4.95 ± 0.71 #	5.35 ± 1.17 #	5.71 ± 0.33 #†

Data are presented as mean ± SD. CG = control group; TG = training group; mini-AQLQ = the mini–asthma quality of life questionnaire. * $p < 0.01$ comparison between groups, # $p < 0.05$ comparison with baseline, and † $p < 0.05$ comparison with week 6.

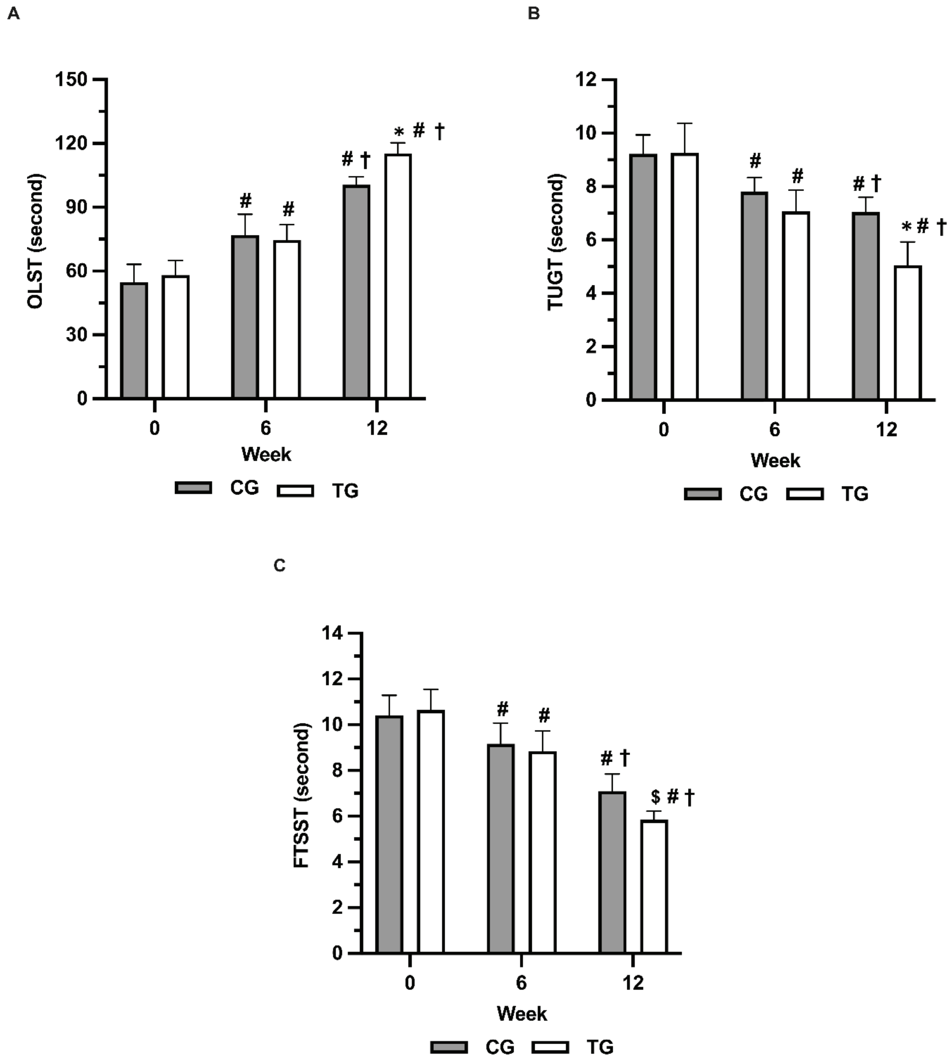

Fig. 1 Comparison of all participants in physical fitness include OLST (A) TUGT (B) and FTSST (C) following the exercise intervention.

CG: control group; TG: training group; OLST: one leg stand test; TUGT: time up and go test; FTSST: five times sit to stand test.

*$p < 0.001$ comparison between groups, $^{\$}$ $p < 0.05$ comparison between groups, # $p < 0.001$ comparison with baseline, and † $p < 0.001$ comparison with week 6.

Conclusion

The results obtained from this study revealed that the 12-week combination of breathing and aerobic exercises effectively improve physical fitness by increasing static and dynamic balance, as well as lower limb muscle strength and improve quality of life by increasing total scores and symptom domain scores in asthmatic patients. These findings have meaningful implications for the use of combination of breathing and aerobic exercises for nonpharmacological intervention in these patients. Further study should investigate the benefits of individualized exercise programs tailored to baseline fitness levels, asthma severity, and personal preferences in order to optimize both adherence and outcomes. Moreover, future research should assess the impact of these programs on clinical outcomes such as pulmonary function, medication usage, and the frequency of asthma exacerbations.

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References

1. Global initiative for asthma. Global strategy for asthma management and prevention. 2025. [cited Feb 1, 2025]. Available from: https://ginasthma.org/2025-gina-strategy-report/.
2. Cordova-Rivera L, Gibson PG, Gardiner PA, Powell H, McDonald VM. Physical activity and exercise capacity in severe asthma: key clinical associations. J Allergy Clin Immunol Pract 2018;6(3):814-22. doi:10.1016/j.jaip.2017.09.022.
3. Basso RP, Jamami M, Labadessa IG, Regueiro EM, Pessoa BV, Oliveira AD Jr., et al. Relationship between exercise capacity and quality of life in adolescents with asthma. J Bras Pneumol 2013;39(2):121-7. doi:10.1590/s1806-37132013000200002.
4. de Lima FF, Pinheiro DHA, de Carvalho CRF. Physical training in adults with asthma: an integrative approach on strategies, mechanisms, and benefits. Front Rehabil Sci 2023;4:1115352. doi:10.3389/fresc.2023.1115352.
5. Cote A, Turmel J, Boulet LP. Exercise and asthma. Semin Respir Crit Care Med 2018;39(1):19-28. doi:10.1055/s-0037-1606215.
6. Bruton A, Thomas M. The role of breathing training in asthma management. Curr Opin Allergy Clin Immunol 2011;11(1):53-7. doi:10.1097/ACI.0b013e3283423085.
7. Santino TA, Chaves GS, Freitas DA, Fregonezi GA, Mendonca KM. Breathing exercises for adults with asthma. Cochrane Database Syst Rev 2020;3(3):CD001277. doi:10.1002/14651858.CD001277.pub4.
8. Evaristo KB, Mendes FAR, Saccomani MG, Cukier A, Carvalho-Pinto RM, Rodrigues MR, et al. Effects of aerobic training versus breathing exercises on asthma control: a randomized trial. J Allergy Clin Immunol Pract 2020;8(9):2989-96 e4. doi:10.1016/j.jaip.2020.06.042.
9. Erdogan Yuce G, Tasci S. Effect of pranayama breathing technique on asthma control, pulmonary function, and quality of life: a single-blind, randomized, controlled trial. Complement Ther Clin Pract 2020;38:101081. doi:10.1016/j.ctcp.2019.101081.
10. Chomiak T, Pereira FV, Hu B. The single-leg-stance test in parkinson's disease. J Clin Med Res 2015;7(3):182-5. doi:10.14740/jocmr1878w.
11. Marques A, Cruz J, Quina S, Regencio M, Jacome C. Reliability, agreement and minimal detectable change of the timed up & go and the 10-meter walk tests in older patients with COPD. COPD 2016;13(3):279-87. doi:10.3109/15412555.2015.1079816.
12. Zampogna E, Pignatti P, Ambrosino N, Cherubino F, Maria Fadda A, Zappa M, et al. The 5-repetition sit-to-stand test as an outcome measure for pulmonary rehabilitation in subjects with asthma. Respir Care 2021;66(5):769-76. doi:10.4187/respcare.08452.
13. Juniper EF, Guyatt GH, Cox FM, Ferrie PJ, King DR. Development and validation of the mini asthma quality of life questionnaire. Eur Respir J 1999;14(1):32-8. doi:10.1034/j.1399-3003.1999.14a08.x.
14. Juniper EF, Guyatt GH, Willan A, Griffith LE. Determining a minimal important change in a disease-specific quality of life questionnaire. J Clin Epidemiol 1994;47(1):81-7. doi:10.1016/0895-4356(94)90036-1.
15. Balady GJ, Weiner DA. Exercise testing for sports and the exercise prescription. Cardiol Clin 1987;5(2):183-96 doi:10.1016/s0733-8651(18)30545-9.
16. American College of Sports Medicine (ACSM). ACSM's resources for the group exercise instructor. 2nd ed. Baltimore: Wolters Kluwer Health; 2022.
17. Sarinukul C, Janyacharoen T, Donpunha W, Nakmareong S, Ruksapukdee W, Sawanyawisuth K. The effects of stepping exercise on blood pressure, physical performance, and quality of life

in female older adults with stage 1 hypertension: a randomized controlled trial. Can Geriatr J 2023;26(1):144-9. doi:10.5770/cgj.26.632.

18. Charee J, Yupaporn K, Khaothin T, Kusump S, Ashira H. The effects of step aerobic training on muscle power and agility in female badminton players. Int J Exerc Sci 2022;15(6):1317-25. doi:10.70252/AMXG6734.
19. Wakeling JM. Motor units are recruited in a task-dependent fashion during locomotion. J Exp Biol 2004;207(Pt 22):3883-90. doi:10.1242/jeb.01223.
20. Stephens RJ, Haas M, Moore WL, 3rd, Emmil JR, Sipress JA, Williams A. Effects of diaphragmatic breathing patterns on balance: a preliminary clinical trial. J Manipulative Physiol Ther 2017;40(3):169-75. doi:10.1016/j.jmpt.2017.01.005.
21. Hodges PW, Eriksson AE, Shirley D, Gandevia SC. Intra-abdominal pressure increases stiffness of the lumbar spine. J Biomech 2005;38(9):1873-80. doi:10.1016/j.jbiomech.2004.08.016.
22. HajGhanbari B, Yamabayashi C, Buna TR, Coelho JD, Freedman KD, Morton TA, et al. Effects of respiratory muscle training on performance in athletes: a systematic review with meta-analyses. J Strength Cond Res 2013;27(6):1643-63. doi:10.1519/JSC.0b013e318269f73f.
23. Janssens L, McConnell AK, Pijnenburg M, Claeys K, Goossens N, Lysens R, et al. Inspiratory muscle training affects proprioceptive use and low back pain. Med Sci Sports Exerc 2015;47(1):12-9. doi:10.1249/MSS.0000000000000385.
24. Lee DK, Kim SH. The effect of respiratory exercise on trunk control, pulmonary function, and trunk muscle activity in chronic stroke patients. J Phys Ther Sci 2018;30(5):700-3. doi:10.1589/jpts.30.700.
25. Bordoni B, Purgol S, Bizzarri A, Modica M, Morabito B. The influence of breathing on the central nervous system. Cureus 2018;10(6):e2724. doi:10.7759/cureus.2724.
26. Franca-Pinto A, Mendes FA, de Carvalho-Pinto RM, Agondi RC, Cukier A, Stelmach R, et al. Aerobic training decreases bronchial hyperresponsiveness and systemic inflammation in patients with moderate or severe asthma: a randomised controlled trial. Thorax 2015;70(8):732-9. doi:10.1136/thoraxjnl-2014-206070.
27. Valkenborghs SR, Wood LG, Callister R, Upham JW, Grainge CL, Anderson S, et al. Effects of moderate-versus vigorous-intensity exercise training on asthma outcomes in adults. J Allergy Clin Immunol Pract 2024;12(10):2744-53 e8. doi:10.1016/j.jaip.2024.06.015.
28. Dogra S, Kuk JL, Baker J, Jamnik V. Exercise is associated with improved asthma control in adults. Eur Respir J 2011;37(2):318-23. doi:10.1183/09031936.00182209.
29. Prem V, Sahoo RC, Adhikari P. Effect of diaphragmatic breathing exercise on quality of life in subjects with asthma: a systematic review. Physiother Theory and Pract 2013;29(4):271–7. doi:10.3109/09593985.2012.731626.
30. Hamasaki H. Effects of diaphragmatic breathing on health: a narrative review. Medicines (Basel) 2020;7(10):65. doi: 10.3390/medicines7100065.
31. Seo Y, Yates B, LaFramboise L, Pozehl B, Norman J.F, Hertzog M. A home-based diaphragmatic breathing retraining in rural patients with heart failure. West J Nurs Res 2016;38(3):270–91. doi:10.1177/0193945915584201.
32. Gosselink R. Breathing techniques in patients with chronic obstructive pulmonary disease (COPD). Chron Respir Dis 2004;1(3):163–72. doi:10.1191/1479972304cd020rs.
33. Rossi A, Aisanov Z, Avdeev S, Di Maria G, Donner CF, Izquierdo JL, et al. Mechanisms, assessment and therapeutic implications of lung hyperinflation in COPD. Respir Med 2015;109(7):785–802. doi:10.1016/j.rmed.2015.03.010.

34. Gosselink R. Controlled breathing and dyspnea in patients with chronic obstructive pulmonary disease (COPD). J Rehabil Res Dev 2003;40 (suppl 2):25-33. doi:10.1682/jrrd.2003.10.0025.

35. Nguyen JD, Duong H. Pursed-lip breathing. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025.

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