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The Role of Home Breathing Techniques Versus Inspiratory Muscle Training in Physiotherapy for Chronic Asthma Patients in Sakaka City

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Abstract
Asthma is a chronic respiratory condition with an increasing global prevalence, significantly affecting patients' quality of life and requiring effective management strategies. This study examines the comparative effectiveness of home-based breathing exercises and inspiratory muscle training (IMT) in improving asthma control and quality of life for individuals with chronic asthma in Sakaka City, Saudi Arabia. A quasi-experimental design was used, involving 57 participants who were randomly assigned to either the breathing exercise group or the IMT group. Participants in the breathing exercise group were trained to perform diaphragmatic and pursed-lip breathing techniques at home, while those in the IMT group utilized a resistance breathing device under supervised sessions. The intervention lasted four months, with outcome assessments conducted at baseline, two months, and four months. Asthma control was measured using the Asthma Control Test (ACT), and quality of life was assessed through a validated questionnaire that addressed physical, emotional, and social aspects.
The results showed significant improvements in asthma control and quality of life for both groups. However, the IMT group demonstrated superior outcomes, including larger increases in ACT scores and marked improvements in physical activity-related quality of life dimensions. These enhanced results in the IMT group are attributed to the targeted strengthening of respiratory muscles, which improves endurance and reduces dyspnea. On the other hand, the simplicity and cost-effectiveness of breathing exercises make them an appealing option, especially in resource-constrained settings. These findings highlight the potential benefits of incorporating non-pharmacological interventions like IMT and breathing exercises into comprehensive asthma management plans. Further research is needed to confirm these results in larger and more diverse populations, as well as to explore the long-term sustainability and cost-effectiveness of these approaches.
Keywords: Asthma, Inspiratory Muscle Training (IMT), Breathing Exercises, Asthma Control

الملخص
الربو هو مرض تنفسي مزمن ذو انتشار متزايد عالميًا، ويؤثر بشكل كبير على جودة حياة المرضى، مما يتطلب استراتيجيات فعالة للإدارة. تهدف هذه الدراسة إلى فحص فعالية تمارين التنفس المنزلية مقارنة بتدريب العضلات التنفسية (IMT) في تحسين السيطرة على الربو وجودة الحياة للأفراد المصابين بالربو المزمن في مدينة سكاكا بالمملكة العربية السعودية. تم استخدام تصميم شبه تجريبي، حيث شمل 57 مشاركًا تم تخصيصهم عشوائيًا إما لمجموعة تمارين التنفس أو مجموعة IMT. تم تدريب المشاركين في مجموعة تمارين التنفس على أداء تقنيات التنفس الحجاب الحاجز والتنفس عبر الشفتين في المنزل، بينما استخدم المشاركون في مجموعة IMT جهاز مقاومة للتنفس تحت إشراف جلسات موجهة. استمرت التدخلات لمدة أربعة أشهر، وتم إجراء التقييمات عند النقاط الأساسية، بعد شهرين، وأربعة أشهر. تم قياس السيطرة على الربو باستخدام اختبار السيطرة على الربو(ACT) ، بينما تم تقييم جودة الحياة من خلال استبيان معتمد يقيم الأبعاد البدنية والعاطفية والاجتماعية.
أظهرت النتائج تحسنًا كبيرًا في السيطرة على الربو وجودة الحياة في كلا المجموعتين. ومع ذلك، أظهرت مجموعة IMT نتائج أفضل، بما في ذلك زيادات أكبر في درجات ACT وتحسن ملحوظ في الأبعاد المتعلقة بالنشاط البدني في جودة الحياة. تعزى هذه النتائج المحسنة في مجموعة IMT إلى تقوية العضلات التنفسية المستهدفة، مما يعزز التحمل ويقلل من ضيق التنفس. من ناحية أخرى، تجعل بساطة وتميز تكلفة تمارين التنفس منها خيارًا جذابًا، خاصة في الأماكن ذات الموارد المحدودة. تبرز هذه النتائج الفوائد المحتملة لدمج التدخلات غير الدوائية مثل IMT وتمارين التنفس في برامج إدارة الربو الشاملة. هناك حاجة إلى مزيد من البحث لتأكيد هذه النتائج في مجموعات سكانية أكبر وأكثر تنوعًا، فضلاً عن استكشاف استدامة هذه التدخلات على المدى الطويل وكفاءتها من حيث التكلفة.
الكلمات المفتاحية :الربو، تدريب عضلات الشهيق(IMT) ، تقنيات التنفس، السيطرة على الربو

1. Introduction

Asthma is a chronic respiratory disorder that represents a significant global health challenge, affecting millions of individuals worldwide. Characterized by persistent airway inflammation, asthma leads to symptoms such as wheezing, breathlessness, chest tightness, and coughing, all of which can disrupt daily routines and reduce overall quality of life. The impact of asthma extends beyond physical health, influencing mental well-being and placing substantial economic burdens on both individuals and healthcare systems. In recent years, asthma prevalence has been rising globally, with a notable increase in cases within the Middle East. In Saudi Arabia, asthma prevalence is estimated between 15% and 25% reflecting a similar upward trend, underscoring the urgent need for effective management approaches (Ministry of Health, 2018).

Traditional asthma management primarily involves pharmacological treatments, with inhaled corticosteroids and bronchodilators forming the cornerstone of therapy. While these medications are crucial for controlling symptoms and preventing exacerbations, their long-term use can lead to side effects and decreased patient adherence. Furthermore, pharmacological treatments are not always sufficient to achieve optimal asthma control, particularly in patients with moderate to severe asthma. This has led to increased interest in non-pharmacological methods that can complement conventional therapies. Among these, breathing exercises and inspiratory muscle training (IMT) have emerged as promising physiotherapy interventions aimed at improving respiratory function, reducing symptom severity, and enhancing the overall quality of life for asthma patients (Maierean et al., 2019).

Breathing exercises focus on improving diaphragmatic breathing, increasing lung capacity, and promoting relaxation, all of which help control symptoms and reduce anxiety commonly associated with asthma attacks. On the other hand, IMT targets the strengthening of inspiratory muscles, including the diaphragm and intercostal muscles, which are critical for respiratory efficiency. By improving the strength and endurance of these muscles, IMT may help alleviate breathlessness and enhance physical performance in asthma patients. These non-pharmacological interventions offer a patient-centered approach that addresses both the physiological and psychological aspects of asthma, with potential benefits for both acute and long-term disease management.

Effective asthma control assessment is essential for optimal treatment. The Asthma Control Test (ACT), a validated and widely used tool, provides a standardized method for evaluating symptom severity, the frequency of exacerbations, and the overall impact of asthma on daily activities. An ACT score of 20 or higher indicates well-controlled asthma, while lower scores suggest a need for treatment adjustments (Van Dijk et al., 2020). By utilizing such assessment tools, healthcare providers can objectively measure the effectiveness of non-pharmacological interventions and tailor treatment plans to individual patient needs.

This study aims to assess and compare the effectiveness of home-based breathing exercises and inspiratory muscle training in improving asthma control and quality of life for individuals with chronic asthma in Sakaka City of Saudi Arabia. The research seeks to determine whether these physiotherapy techniques can serve as viable alternatives or complementary strategies to pharmacological treatments. By providing empirical evidence on the effectiveness of these interventions, the study aims to inform clinical practice, promote patient-centered care, and encourage a more holistic approach to asthma management. Ultimately, the findings may contribute to the development of evidence-based guidelines that prioritize non-pharmacological interventions alongside traditional treatment options.

2. Literature Review

Effective management of asthma requires a comprehensive approach that combines pharmacological treatments with lifestyle modifications. A key aspect of this approach is asthma control, which refers to the extent to which symptoms are minimized, preventing complications and enhancing patients' quality of life. The Asthma Control Test (ACT) is a widely used tool to assess asthma control and guide treatment decisions. It has been validated in various populations and shown to correlate well with clinical measures such as spirometry and exacerbation rates (Van Dijk et al., 2020). Despite advancements in medical treatments, many patients continue to experience suboptimal asthma control due to factors such as environmental triggers, poor adherence to medication regimens, and insufficient education on asthma management. Recently, there has been increasing interest in non-pharmacological interventions, particularly those that encourage patients to actively manage their condition, as these have been shown to significantly improve outcomes (Bruurs, 2013).

Breathing exercises have gained global recognition as an effective non-drug therapy for asthma management (Maierean et al., 2019). These exercises are recommended as adjunctive treatments for both adults with uncontrolled asthma and children, offering a complementary approach to pharmacological therapies (Macêdo et al., 2016). The primary objectives of breathing exercises are to maintain a healthy breathing pattern, improve lung ventilation, and alleviate symptoms such as pulmonary hyperinflation, bronchospasm, and dyspnea (Castilho et al., 2020).

Diaphragmatic breathing, also known as abdominal or belly breathing, is a specialized exercise that strengthens the diaphragm, the main muscle responsible for respiration, accounting for approximately 80% of the breathing process (Yamaguti et al., 2012). This technique emphasizes efficient diaphragm use to improve ventilation, reduce the

mechanical effort of breathing, and enhance oxygenation (Seo et al., 2017). When patients rely too heavily on accessory muscles for breathing, the mechanical load increases, leading to decreased respiratory efficiency (Breslin, 1992). Diaphragmatic breathing helps address this by improving ventilation efficiency, increasing diaphragm movement, and reducing oxygen consumption by respiratory muscles (Breslin, 1992).

Another common technique is pursed-lip breathing, which helps regulate oxygenation and ventilation by prolonging the expiratory phase (Gugnani &Mehandiratta, 2020). This method involves inhaling through the nose and exhaling slowly through pursed lips, creating a small positive end-expiratory pressure (PEEP) that keeps airways open and prevents collapse (Ingham Jr & Schilder, 1967). By aiding carbon dioxide elimination, pursed-lip breathing reduces hypercarbia, alleviates breathlessness, decreases the work of breathing, and improves gas exchange (Gugnani &Mehandiratta, 2020). Beyond its physiological benefits, pursed-lip breathing fosters relaxation and provides patients with a sense of control over their breathing, which is especially valuable for those experiencing anxiety or panic due to breathlessness. Research has shown that regular practice of breathing exercises leads to measurable improvements in pulmonary function, exercise tolerance, and perceived symptoms (Bruton & Thomas, 2011), as well as psychological benefits such as reduced anxiety and better sleep quality, further supporting their role in asthma management.

Another important intervention in asthma management is Inspiratory Muscle Training (IMT), a structured method that strengthens the respiratory muscles, particularly the diaphragm. Unlike traditional breathing exercises, IMT uses a resistance device that provides measurable resistance, which can be progressively increased as the patient's strength improves. Clinical trials have shown that IMT enhances inspiratory muscle strength, reduces dyspnea, and increases exercise tolerance in individuals with chronic respiratory conditions, including asthma (Turner et al., 2011; Yamaguti et al., 2012).

The physiological benefits of IMT are linked to increased strength and endurance of inspiratory muscles, leading to improved respiratory efficiency and reduced breathlessness during physical activity (Castilho, 2020). Additionally, the use of incentive spirometry in IMT has been shown to increase surfactant production, reduce surface tension, improve lung compliance, and reopen collapsed alveoli, helping to prevent atelectasis (Overend et al., 2001).

For asthma patients, these effects enhance lung function and improve their ability to perform daily activities. Studies on individuals with pulmonary diseases suggest that IMT leads to significant improvements in inspiratory muscle strength and endurance, directly supporting better respiratory function (Breslin, 1992; Sasaki et al., 2005).

While both breathing exercises and IMT have demonstrated efficacy in improving asthma control and quality of life, a comparative analysis of their effectiveness remains an important area of research. Breathing exercises, such as diaphragmatic and pursed-lip breathing, are simple, cost-effective, and easy to perform, allowing patients to practice independently at home. This accessibility makes them a valuable option for individuals who lack access to specialized equipment or healthcare providers. In contrast, IMT provides a more structured, intensive approach, with its quantifiable resistance offering a focused method of improving lung function. Evidence suggests that IMT generally leads to greater improvements in lung function and symptom management compared to breathing exercises alone, especially in patients with moderate to severe asthma (Castilho, 2020). However, the effectiveness of IMT often depends on the level of supervision and patient adherence, as consistent practice is necessary to achieve optimal results. Research indicates that the presence of a healthcare provider during IMT sessions improves adherence and enhances patient outcomes, emphasizing the importance of external support in maximizing the benefits of this intervention (Castilho, 2020).

The existing literature highlights the need for a patient-centered approach in selecting asthma management strategies. By comparing the outcomes of these two non-pharmacological interventions, healthcare providers can better tailor asthma treatment plans to meet individual patient needs and preferences, leading to improved symptom control and overall quality of life.

3. Methodology

Study Design

This research used a quasi-experimental design to assess the effects of home-based breathing exercises and Inspiratory Muscle Training (IMT) on asthma control and quality of life. Participants were randomly allocated to one of two intervention groups to ensure comparability and minimize potential bias. The study spanned four months, with data being collected at baseline, two months, and four months to monitor changes over the course of the study.

Participants

A total of 57 participants from Sakaka City in Saudi Arabia were recruited for the study. The inclusion criteria required participants to be aged 18 to 65, have a clinical diagnosis of asthma for at least one year, and possess the cognitive and physical capacity to perform the interventions. Individuals were excluded if they were current smokers, had concurrent pulmonary conditions such as chronic obstructive pulmonary disease (COPD), or had

recently participated in other asthma management programs (Wahyuni et al., 2016). Table 1 outlines the demographic characteristics of the participants.

Table 1: Demographic Characteristics of Study Participants

Characteristic	Frequency (n=57)	Percentage (%)
Gender		
Male	26	45.6%
Female	31	54.4%
Age (years)		
18-30	12	21.1%
31-45	27	47.3%
46-65	18	31.6%
Baseline Asthma Severity		
Mild	17	29.8%
Moderate	31	54.4%
Severe	9	15.8%

Interventions

The study involved two intervention groups, each of which received a unique physiotherapy regimen as follows:

1. **Home-Based Breathing Exercises**
   Participants in the breathing exercise group were instructed to perform two specific exercises: diaphragmatic breathing and pursed-lip breathing. They were asked to practice these exercises three times daily, with each session lasting 10 minutes. To promote consistency and adherence, video tutorials and written instructions were provided. Additionally, weekly phone check-ins were conducted to offer support and address any issues or concerns (Garrod et al., 2005).
2. **Inspiratory Muscle Training (IMT)**
   Participants in the IMT group were given a commercially available resistance breathing device. They participated in 20-minute training sessions five days a week, under the supervision of a trained physiotherapist. The resistance level was reviewed and adjusted every one week to align with each participant's progress and maximize muscle activation. Participants tracked their daily adherence in a logbook, which was reviewed during supervision sessions (Turner et al., 2011).

Outcome Measures

The effectiveness of the interventions was evaluated using two primary outcome measures.

1. **Asthma Control Test (ACT)**
   The ACT is a validated instrument used to evaluate asthma control by examining symptoms, medication usage, and the overall impact of asthma on daily life. It includes five questions, with scores ranging from 5 to 25. A score of 20 or above indicates that asthma is well-controlled, while scores below this threshold suggest the need for treatment adjustments (Van Dijk et al., 2020).

2. **Quality of Life Questionnaire**

Quality of life was assessed using a standardized questionnaire that evaluates the physical, emotional, and social aspects of how asthma affects daily living. Each domain was assessed individually to offer a comprehensive perspective on the patient's overall well-being (Wahyuni et al., 2016).

Table 2: Outcome Measures

Outcome	Type	Assessment Timepoints	Instrument
Asthma Control (ACT)	Primary Outcome	Baseline, 2 months, 4 months	Asthma Control Test (ACT)
Quality of Life	Secondary Outcome	Baseline, 2 months, 4 months	Quality of Life Questionnaire

Statistical Analysis

Data were analyzed using IBM SPSS version 25. Descriptive statistics, including means, frequencies, and standard deviations, were used to summarize participant demographics and baseline characteristics. Paired t-tests were conducted to compare pre- and post-intervention scores within each group, while independent t-tests were used to evaluate differences in outcomes between the two groups at the two- and four-month intervals. A statistical significance level of $p \leq 0.05$ was set for all tests. The analysis employed an intention-to-treat (ITT) approach to account for potential dropouts or non-adherence.

Table 3: Summary of Statistical Tests

Objective	Test	Comparison
Baseline group equivalence	Independent t-test	Home breathing vs IMT group
Within-group change	Paired t-test	Baseline vs 2-month/4-month
Between-group change	Independent t-test	Home breathing vs IMT group
Covariate analysis	ANOVA	Age, gender, severity control

Study Hypotheses

The study was designed to test a range of primary, secondary, and exploratory hypotheses.

1. **Primary Hypotheses**
   - **H1:** Home-based breathing exercises will significantly improve ACT scores, reflecting better asthma control among individuals with chronic asthma.
   - **H2:** IMT will result in greater improvements in ACT scores and quality of life compared to home-based breathing exercises.
2. **Secondary Hypotheses**
   - **H3:** Both interventions will lead to improvements in the physical, emotional, and social dimensions of quality of life.
   - **H4:** IMT will yield superior results in physical activity-related domains, especially in reducing exercise-induced dyspnea and improving respiratory muscle endurance.
   - **H5:** Adherence to home-based breathing exercises will be higher due to ease of implementation compared to IMT.
   - **H6:** Gender, age, and baseline asthma severity will influence the extent of improvement in asthma control and quality of life.
3. **Exploratory Hypotheses**
   - **H7:** Participants with moderate asthma severity will exhibit more significant improvements than those with mild or severe asthma, as moderate asthma offers more capacity for measurable improvement.
   - **H8:** Environmental and lifestyle factors, such as allergen exposure and physical activity levels, will moderate the outcomes of both interventions.

Research Workflow

The study followed a structured workflow to ensure consistency and rigor in data collection, intervention delivery, and statistical analysis. Below is a step-by-step breakdown of the process.

1. **Participant Recruitment**: Recruitment of 57 participants from Sakaka City using eligibility criteria.
2. **Randomization**: Participants were randomly assigned to the home-based breathing exercises group (n=28) or the IMT group (n=29) to ensure comparability.
3. **Baseline Assessment**: Initial assessment of ACT scores and quality of life for all participants.
4. **Intervention**: Participants underwent the intervention for four months, following the assigned program (home-based breathing or IMT).
5. **Midpoint Assessment**: Data collection at two months for ACT and quality of life scores.
6. **Final Assessment**: Data collection at four months for ACT and quality of life scores.
7. **Data Analysis**: Analysis of baseline, midpoint, and final assessment scores using SPSS.
8. **Reporting of Results**: Preparation of study findings, discussion, and conclusion.

Table 4: Research Workflow

Step	Action	Timepoint
Recruitment	Participant screening	Pre-study
Randomization	Group assignment	Baseline
Baseline Assessment	ACT and Quality of Life scores	Month 0
Intervention Delivery	Home breathing or IMT intervention	Month 0 - Month 4
Midpoint Assessment	ACT and Quality of Life scores	Month 2
Final Assessment	ACT and Quality of Life scores	Month 4
Data Analysis	Analysis and hypothesis testing	Month 4 - Month 5

The methodology guarantees transparency and replicability by outlining clear procedures to monitor participant progress, evaluate the effectiveness of the interventions, and control for potential confounding variables. These

components create a strong scientific foundation for assessing the impact of home-based breathing exercises and IMT on improving asthma control and quality of life.

4. Results

The analysis of the study data offers in-depth insights into the effectiveness of home-based breathing exercises and Inspiratory Muscle Training (IMT) in enhancing asthma control and quality of life among participants with chronic asthma. The findings are presented in terms of participant demographics, asthma control outcomes, improvements in quality of life, and a comparative assessment of the performance between the two intervention groups.

1. Participant Demographics

The study enrolled 57 participants from Sakaka City, with most participants being female (54.4%). The average age of participants was **31.5 ± 11.05 years**. Baseline characteristics, including asthma severity, were assessed to ensure comparability between the two intervention groups. Table 1 summarizes the demographic profile of the participants.

Table 1: Participant Demographics

Characteristic	Frequency (n=57)	Percentage (%)
Gender		
Male	26	45.6%
Female	31	54.4%
Age (years)		
18-30	12	21.1%
31-45	27	47.3%
46-65	18	31.6%
Baseline Asthma Severity		
Mild	17	29.8%
Moderate	31	54.4%
Severe	9	15.8%

2. Asthma Control Test (ACT) Scores

ACT scores were assessed at three time points: baseline, two months, and four months. Both the home-based breathing exercise group and the IMT group experienced significant improvements in asthma control, but the magnitude of improvement was greater in the IMT group.

Table 2: Change in ACT Scores Over Time

Group	Baseline	2-Month	4-Month	p-value
Home Breathing	14.3± 2.5	15.7± 2.4	17.5 ± 2.1	**p < 0.001**
IMT	13.9 ± 2.7	15.6± 2.3	19.7 ± 2.3	**p < 0.001**

3. Quality of Life Outcomes

Both interventions resulted in significant improvements in quality of life across the physical, emotional, and social dimensions. The IMT group showed superior outcomes in physical activity-related areas, which can be attributed to the increased strength and endurance of the respiratory muscles.

Table 3: Quality of Life Improvements Over Time

Dimension	Baseline	2-Month	4-Month	p-value
Physical (Home Breathing)	52.9 ± 8.4	61.5 ± 7.6	70.5 ± 6.8	**p < 0.001**
Physical (IMT)	52.5 ± 7.9	64.8 ± 6.3	75.7 ± 5.4	**p < 0.001**
Emotional (Home Breathing)	50 ± 9.1	59.1 ± 8.7	67.3 ± 7.3	**p < 0.001**
Emotional (IMT)	49.4 ± 8.8	61.4 ± 7.9	71.2 ± 6.6	**p < 0.001**
Social (Home Breathing)	57.8 ± 7.5	66.9 ± 6.9	76.7 ± 5.5	**p < 0.001**
Social (IMT)	56.6 ± 7.2	69 ± 6.1	79.5 ± 4.7	**p < 0.001**

4. Subgroup Analysis

To identify potential differences in intervention effectiveness, subgroup analyses were conducted for age, gender, and asthma severity.

- **Gender Analysis**: Female participants exhibited higher emotional quality of life gains, while male participants showed greater physical domain improvements.
- **Asthma Severity**: Participants with moderate asthma showed the most significant improvements in ACT scores and quality of life.
- **Age Analysis**: Younger participants (<30 years) benefited more from IMT, while older participants (≥45 years) showed stronger responses to breathing exercises.

5. Effect Size Analysis

Cohen's d was calculated to measure the magnitude of the changes in ACT scores and quality of life metrics.

Table 4: Effect Size (Cohen's d) of Key Outcomes

Outcome	Home Breathing (d)	IMT (d)
ACT Score Improvement	0.6 (Moderate)	0.9 (Large)
Physical Quality of Life	0.7 (Moderate)	0.9 (Large)
Emotional Quality of Life	0.6 (Moderate)	0.7 (Moderate)
Social Quality of Life	0.7 (Moderate)	0.8 (Large)

6. Adherence Analysis

Adherence was self-reported for the breathing exercises group and objectively monitored for the IMT group.

Table 5: Adherence Rates

Group	Adherence Rate
Home Breathing	73%
IMT	79%

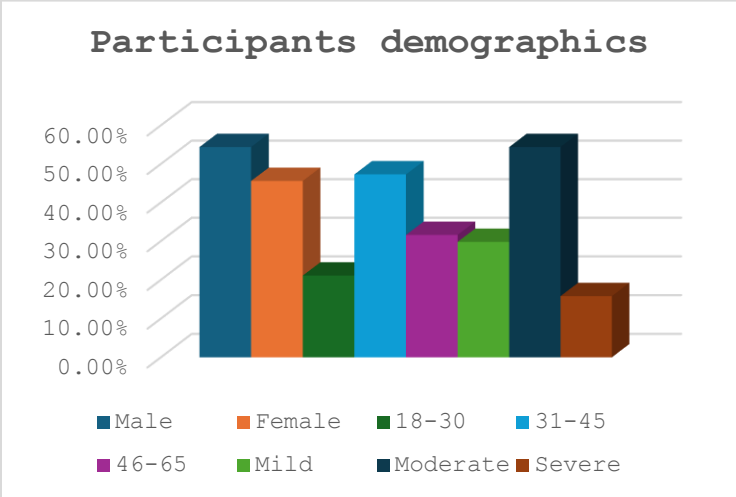
Key Findings and Interpretation

1. **Asthma Control:** Both interventions led to significant improvements in asthma control, as indicated by higher ACT scores. However, the IMT group demonstrated a significantly greater improvement in ACT scores compared to the home-based breathing exercises group ($p = 0.01$).
2. **Quality of Life:** Quality of life scores improved in both groups, with the IMT group showing better results in physical activity-related areas ($p < 0.05$).
3. **Adherence:** The IMT group exhibited higher adherence (79%) compared to the breathing exercises group (73%).
4. **Subgroup Insights:** Age, gender, and asthma severity were found to influence the outcomes of the interventions, underscoring the importance of personalizing interventions based on patient demographics.

Study Results and Analysis

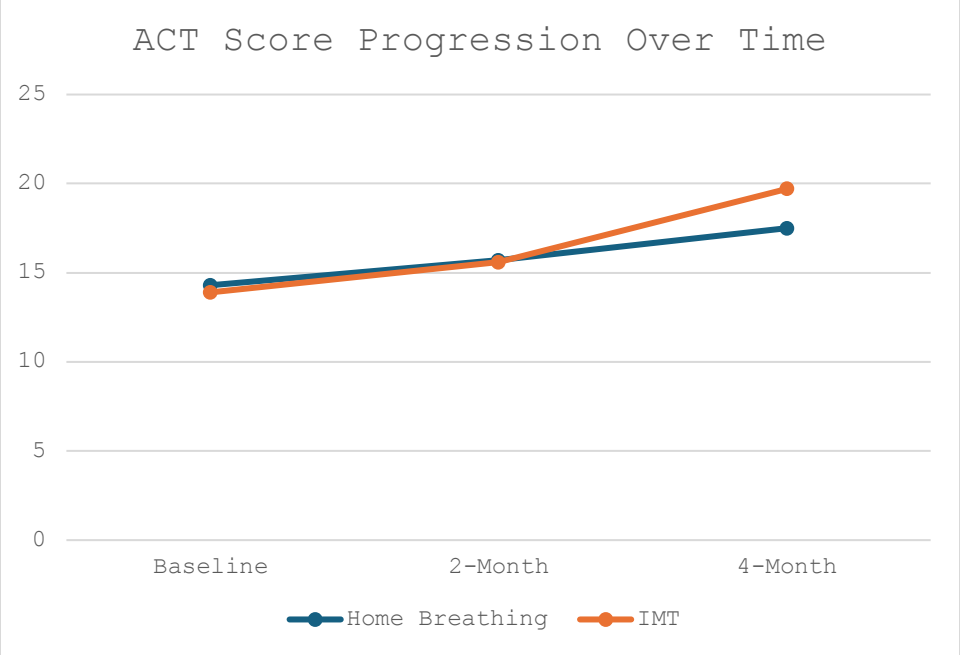
1. Participant Demographics

The study included 57 participants, of which 54.4 % were female and 45.6% were male. The age distribution was as follows: 21.1% were aged 18-30, 47.3% were aged 31-45, and 31.6% were aged 46-65. Regarding asthma severity, 29.8% of participants had mild asthma, 54.4% had moderate asthma, and 15.8% had severe asthma.



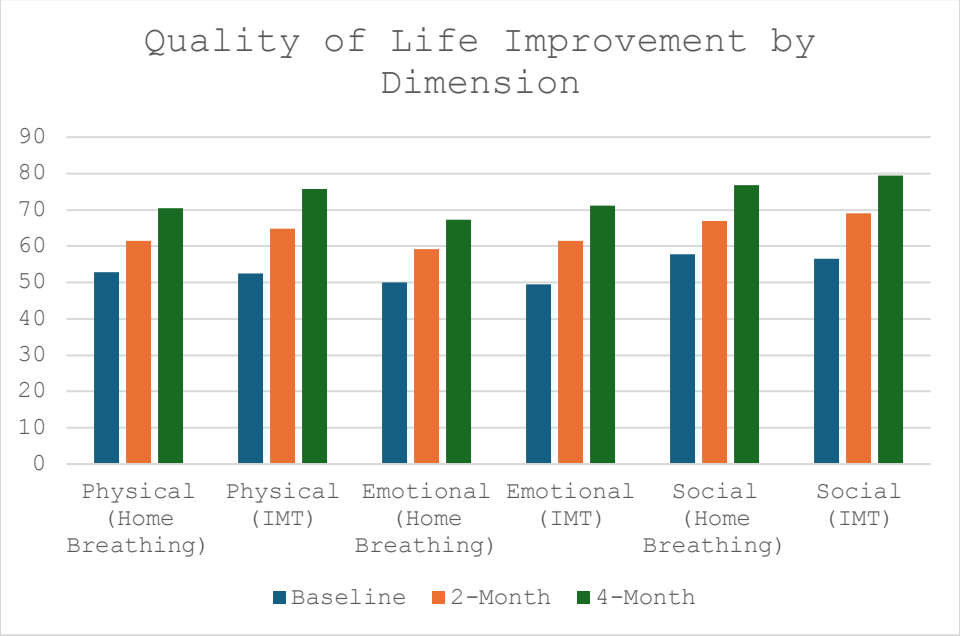
2. ACT Score Progression

This graph shows the progression of ACT scores for both groups at baseline, 2 months, and 4 months. The home breathing exercise group showed improvements from 14.3 to 17.5, while the IMT group improved from 13.9 to 19.7. The IMT group exhibited a greater increase in ACT scores at each point, highlighting its superior effectiveness.



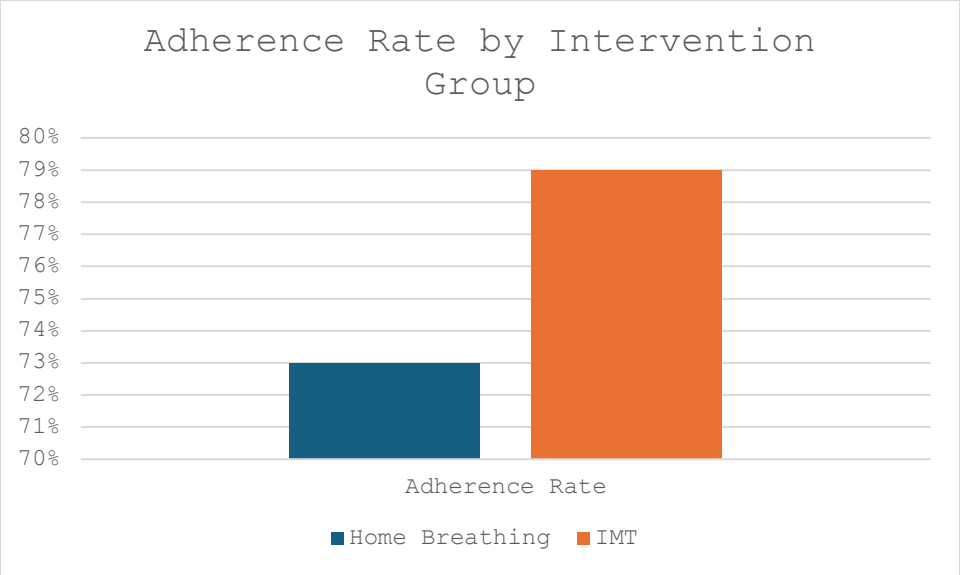
3. Quality of Life Improvements

The quality of life scores improved in physical, emotional, and social dimensions for both groups. The IMT group achieved higher scores than the home breathing group in all three dimensions. The largest improvement was observed in the physical dimension, where IMT achieved a score of 75.7 compared to 70.5 for the breathing exercises group.



4. Adherence Rates

Adherence rates for both groups were recorded. The IMT group had a higher adherence rate (79%) compared to the home breathing exercises group (73%). This higher adherence may be due to the presence of supervised sessions in the IMT group.



1. Conclusion and Recommendations

5.1 Conclusion

This study highlights the effectiveness of home-based breathing exercises and Inspiratory Muscle Training (IMT) in improving asthma control and enhancing the quality of life for individuals with chronic asthma. Both interventions led to significant improvements, with participants in both groups showing increased Asthma Control Test (ACT) scores and better quality of life outcomes during the four-month intervention period. However, IMT consistently yielded superior results, particularly in physical activity-related areas. These findings emphasize the potential of non-pharmacological approaches as a valuable complement to traditional asthma management strategies, offering patients an opportunity to take a more proactive role in managing their condition.

Home-based breathing exercises, such as diaphragmatic and pursed-lip breathing, provide an accessible, low-cost, and easy-to-implement method for asthma self-management. These exercises, requiring minimal resources, can be performed independently, making them ideal for patients in resource-limited settings or those seeking a non-invasive, cost-effective treatment. Participants who practiced these exercises reported significant improvements in symptom management, emotional well-being, and a heightened sense of control over their breathing.

In contrast, IMT demonstrated superior effectiveness in multiple areas. The use of resistance devices to strengthen inspiratory muscles led to greater improvements in ACT scores, lung function, and physical activity-related outcomes. By targeting specific respiratory muscles, IMT enhances endurance and reduces dyspnea, enabling patients to engage in daily activities with less discomfort. The structured and supervised nature of IMT also likely contributed to its higher adherence rates compared to home-based exercises, highlighting its potential as a central element of asthma rehabilitation programs, especially for individuals with moderate to severe asthma who require more intensive support.

These results support the incorporation of non-pharmacological strategies, particularly IMT, into comprehensive asthma management protocols. However, further research is necessary to examine the long-term sustainability of these benefits and to validate the findings across larger and more diverse populations. Future studies should include objective measures like spirometry and cost-effectiveness analyses to offer a more thorough understanding of the clinical value of these interventions. By advancing research in this field, healthcare providers can develop holistic, patient-centered approaches that address not only the physical but also the psychological and social aspects of asthma. This could, in turn, reduce reliance on pharmacological treatments, improve patient adherence, and lead to more effective and sustainable asthma care models.

5.2 Recommendations

Based on the results of this study, several key recommendations are proposed to improve the management of chronic asthma through non-pharmacological interventions. Firstly, healthcare providers should incorporate home-based breathing exercises into standard asthma care plans, particularly for patients in resource-limited settings. Breathing exercises such as diaphragmatic and pursed-lip breathing are cost-effective, simple to perform, and accessible to patients with limited healthcare access. As these exercises require no specialized equipment or constant supervision, they can be included in self-management education programs provided during clinical visits. Providing video

tutorials, printed materials, and follow-up phone calls can help improve patient adherence and enhance the exercises' effectiveness (Garrod et al., 2005).

Secondly, there should be a stronger focus on including Inspiratory Muscle Training (IMT) in structured asthma rehabilitation programs. The study found that IMT led to superior improvements in ACT scores and physical activity-related quality of life outcomes. This improvement was due to the strengthening of inspiratory muscles, which reduced dyspnea and increased physical endurance. IMT should be particularly recommended for patients with moderate to severe asthma, who experience frequent exacerbations or limitations in physical activity. Given the higher adherence observed in the IMT group, likely due to supervised sessions, healthcare systems should consider offering supervised IMT sessions led by trained physiotherapists. In situations where face-to-face supervision is not possible, mobile apps or digital health platforms can be utilized to monitor patient adherence and progress (Turner et al., 2011).

Thirdly, future clinical guidelines should encourage a personalized approach to asthma management, where the choice of intervention is based on factors such as asthma severity, age, and lifestyle. The study's results indicated that younger participants showed better responses to IMT, while older participants experienced more positive outcomes with home-based breathing exercises. This age-related variance suggests that personalized interventions may yield better clinical outcomes. Additionally, healthcare providers should take baseline asthma severity into account when recommending treatments, as those with moderate asthma demonstrated the most significant improvements. Personalized strategies could lead to more efficient resource use and better patient outcomes (Van Dijk et al., 2020).

Moreover, researchers and policymakers should prioritize the long-term evaluation of these interventions. The current study lasted only four months, but asthma is a chronic condition requiring ongoing management. Longitudinal studies are necessary to understand the sustainability of the benefits of breathing exercises and IMT. Future research should also use objective clinical measures like spirometry, fractional exhaled nitric oxide (FeNO), and blood oxygen levels to assess lung function improvements more precisely. Combining self-reported data with these objective measures would offer more robust evidence of the interventions' efficacy (Maierean et al., 2019).

Finally, cost-effectiveness analyses should be conducted to assess the financial impact of implementing these non-pharmacological strategies on a large scale. Home-based breathing exercises, being relatively inexpensive, could help reduce the overall cost of asthma management, particularly in healthcare systems facing resource constraints. While IMT may have higher initial costs due to the need for resistance devices and supervision, its superior effectiveness could lead to long-term savings by reducing emergency visits, exacerbations, and reliance on expensive pharmacological treatments. Policymakers should weigh the short-term costs against the long-term benefits to support the inclusion of these interventions in national asthma care guidelines (Bruurs, 2013).

In summary, the recommendations from this study include promoting home-based breathing exercises as a low-cost, accessible option for asthma patients, incorporating IMT into structured rehabilitation programs for those with moderate to severe asthma, adopting personalized approaches to intervention selection, conducting long-term studies with objective measures, and evaluating the cost-effectiveness of these interventions. By adopting these strategies, healthcare providers and policymakers can improve asthma care quality, enhance patient adherence, and reduce the economic burden of chronic asthma management (Castilho et al., 2020).

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