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Effect of Matrix Rhythm Therapy (MaRhyThe©) On Bronchial Hygiene: A Pilot Randomized Control Trial

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Abstract

Background and Purpose:

Chronic respiratory diseases is prevalent in India account for 32% of the total population, among which COPD and Asthma are majorly predominant with 75.6% and 20% respectively. With the burden of the disease being so high, multimodal approach is required to cater to the symptoms effectively. Matrix Rhythm Therapy (MaRhyThe©), a novel treatment approach, focuses on correcting the disrupted rhythms at the cellular level which promotes healing and restores normal physiological and functional levels in the body. Hence, aim of the study was to determine and compare the impact of MaRhyThe© and conventional chest -physiotherapy on bronchial hygiene.

Methods:

30 individuals were recruited and randomized into two groups of 15 each; Control or Experimental using an online random number generator. The Control group was given conventional physiotherapy (Flutter and breathing exercises), while the Experimental group received two additional sessions of MaRhyThe© in addition to conventional physiotherapy. Outcome measures, including sputum quantity, PFT values, and chest expansion at three different levels were recorded at baseline and on the 7th day for both groups. Both groups received treatment twice a day for 7 days.

Results:

The intragroup data analysis showed that both the groups, individually, showed statistically significant improvement in all three variables ($p<0.05$) except FEV_1/FVC ratio. Intergroup analysis showed a statistical significance in group B in improving secretion clearance and thoracic excursion, as evidenced by the significant differences in those two parameters. ($p<0.05$)

Conclusion:

MaRhyThe© shows great potential as a treatment that could significantly enhance Bronchial Hygiene, although it may require extended treatment periods in order to see positive effects on PFT parameters.

Key Words: Chest physiotherapy, Flutter, Matrix Rhythm Therapy, Pulmonary Function Test

Introduction

World Health Organization (WHO) defines chronic respiratory conditions as "Any diseases affecting the airways and other structures of the lung" [(1)] that leads to multiple signs and symptoms. Few of the presentations noted in people with disorders of the respiratory system are shortness of breath, cough, and decreased exercise capacity, all of which significantly impair or lower their quality of life.[(2)] There are several respiratory conditions that fall under this definition including, Bronchial Asthma, Chronic Obstructive Pulmonary Disease (COPD), Cystic Fibrosis, Pleural Effusion, Pneumonia, Tuberculosis (TB), Bronchiectasis, and more. According to a study published in The Lancet, the Global Burden of Diseases, India has a huge prevalence of chronic respiratory

diseases, accounting for almost 32% of the population,[3] among which COPD and Asthma are major predominant with 75.6% and 20% respectively. This burden has a significant impact on the QOL of those having to live with it. When a pathological problem exists, i.e. the regular functioning of any of the components of the entire respiratory system is disrupted or interrupted, it can lead to a range of respiratory disorders, that's when illness exists.

Pulmonary rehabilitation is an effective way to improve the lives of individuals with chronic respiratory diseases. It helps reduce symptoms, boost physical function, and facilitate long-term adherence to healthy behaviours.[4] Reducing breathlessness, improving the exercise capacity, keeping the patients updated and educating them about their current condition and the importance of physiotherapy in alleviating the symptoms, helping reduce the number of days at the hospital and early weaning from the ventilator, if required to be put on one, are few of the things a therapist works for.[5]

The term "Bronchial Hygiene Therapy" (BHT) encompasses various airway clearance techniques that are utilized to assist individuals who struggle to effectively eliminate pulmonary secretions. These techniques encompass a range of procedures such as chest physiotherapy, which includes methods like manual hyperventilation (used for intubated patients), breathing exercises, postural drainage, vibration, percussion, coughing, and suctioning, in addition to the use of bronchodilators and mucus-thinning drugs. BHT's primary aim is to facilitate the removal of secretions, increase lung capacity, protect airways, and maintain warm humidity, all of which ultimately aid in improving ventilation and gas exchange.[6]

Dr. Ulrich Randoll has conducted research on cellular health and demonstrated that healthy living cells typically pulsate at a frequency of 8-12 Hz. When the body is afflicted by illness or pathological conditions, cellular rhythms become disrupted, leading to altered cellular organization. Therefore, it is crucial to address cellular metabolism first before proceeding to larger-scale rehabilitation of muscles or systems within the body. Hence, Dr. Randoll developed Matrix Rhythm Therapy (MaRhyThe©), a cutting-edge technology that has been shown to be effective in restoring cellular rhythms to their natural frequency and promoting healing.[7,8] An interesting and a noteworthy thing to highlight about Matrix Rhythm Therapy, is that, the treatment maintains a holistic approach that extends beyond just the symptomatic treatment. It targets the most critical levels of the body's functioning, such as the regulation of cellular metabolism and the microcirculation systems.[7,8,9] By addressing the fundamental unit of the body, the cell, MaRhyThe© has been shown to produce significantly positive effects in many pathological conditions, such as plantar fasciitis, frozen shoulder, and lymphedema.[10,11,12] MaRhyThe© has proven effective in promoting faster recovery times in combination with conventional treatments for various medical conditions. This has sparked interest in exploring its potential applications in different physiotherapy fields and specialties.

With the burden of the disease being so high, multimodal approach is required to cater the symptoms effectively. Chest physiotherapy clear airways through manual vibrations and forced expiratory techniques, but it requires expertise and strength on physiotherapists' part and can be tiring. To address this, mechanical devices such as mechanical chest vibrator or airway clearance devices have been developed, but their outcomes are similar to manual therapy without statistical variation.[12,13] MaRhyThe© produces synchronized vibrations at a cellular level, which may help loosen and mobilize secretions and improve breathing patterns. Multiple studies have shown that incorporating MaRhyThe© into standard physiotherapy protocols has hastened the recovery process manifold in a less amount of time. However, despite the promising benefits of MaRhyThe© there is a dearth of literature on the effectiveness of MaRhyThe© in COPD or any other cardiopulmonary disorders. Further research is essential to ascertain and explore the potential of MaRhyThe© and determine the most effective treatment strategies for individuals with chronic respiratory conditions.

Purpose

To determine and compare the effect of MaRhyThe© and routine chest physiotherapy on secretion clearance, oxygenation, chest wall excursion and mobility using sputum induction, pulmonary function tests and thoracic expansion respectively.

Our null hypothesis stated that there will be no difference in the effect of Matrix Rhythm Therapy and routine chest physiotherapy on bronchial hygiene whereas, the alternative hypothesis stated that there will be a difference in the effect of Matrix Rhythm Therapy and routine chest physiotherapy on bronchial hygiene.

Materials And Methods

Ethical Considerations

Ethical considerations were presented to the Institutional Ethical Committee, and the study was registered with the CTRI under the registration number CTRI/2022/09/045169. Additionally, all individuals who were being recruited to participate in the study were required to give written informed consent. This consent included permission for any necessary information or photographs related to the study to be published, but only after their identity had been concealed.

Study settings and design

This experimental study was a randomized control trial conducted at inpatient department of Dr. KLES Prabhakar Kore Hospital and Medical Research Centre, Belagavi where data was collected from inpatient respiratory medicine wards of a tertiary care hospital and treated at the Physiotherapy Department of KAHER Institute of Physiotherapy, Belagavi. The study was fulfilled over a period of 12 months (April 2022 to March 2023).

Participants and Randomization

Participants were screened based on specific inclusion and exclusion criteria, and 36 were recruited for the study. Randomization was conducted to reduce the potential for bias or confounding factors. The allocation of participants into the control and experimental groups was conducted using a computer-generated random number generator (available at https://www.randomizer.org/). This ensured that any observed differences between the groups were solely due to the intervention being studied, rather than any other factors such as pre-existing differences between participants or other external factors. Participants willing to take part, subjects in the age group of 21-65 years of all genders, participants with any pulmonary condition (except active infections) having productive cough, subjects able to cough actively and voluntarily were included in the study whereas, unstable patients (patients on ventilator, intubated patients, patients with arrhythmias, angina), subjects with rib fractures in the last 6 months, recent surgeries of neck and thoracic region (including patients with chest drains) in last 6 months, having open wounds/scars on the thoracic region, participants with cognitive deficits and GCS score < 8 were excluded from the study. (*Figure 1)*

After obtaining informed consent, a baseline evaluation was conducted and three outcome measures were documented: quantity of sputum in millilitres, pulmonary function test (PFT) values, and thoracic expansion at three levels in centimetres. These outcome measures were documented both prior to and after intervention, i.e. on the 7th day.

Group A was provided with regular chest physiotherapy, while Group B was given both regular chest physiotherapy and Matrix Rhythm Therapy..

Procedure for interventions

This study included various exercises and treatment sessions that were conducted with the assistance and direction of a trained and qualified physiotherapist and were designed to improve respiratory function and provide symptomatic relief, namely, Flutter, Diaphragmatic Breathing Exercise, Thoracic Expansion Exercises, Pursed Lip Breathing Exercises and Matrix Rhythm Therapy. We used evidence-based techniques to provide effective and safe interventions that could be of benefit to those experiencing respiratory issues. The interventions were carefully monitored to ensure they were being performed correctly and safely.

Group A: Routine Chest Physiotherapy *(Figure 3)*

The interventions given to group A participants were:

a) Flutter: The patient was in sitting position and was demonstrated and explained the correct use of the flutter device by the researcher. Next, the patient was directed to take a deep breath in through their nostrils and exhale slowly using the mouthpiece. 3 sets of 15 repetitions were given, interspersed with breathing control between each set. (Fig 3a.)
b) Diaphragmatic Breathing Exercise: The subject was in semi-fowlers position, with hands placed over the upper abdomen just below the anterior costal margin. After that, she / he was told to take a big breath in via their nose and then gently exhale through the mouth. They were instructed that abdominal wall should rise with inspiration and fall with expiration. The subject was made aware of any accessory muscle usage and was educated to avoid or stop using them. (Fig 3b.)
c) Thoracic Expansion Exercises: The subjects were in sitting position. They were instructed to take a deep breath in, while performing the exercises shown, one at a time, hold the breath for 3 seconds, and then gently release while returning to the original position. This was given for 3 sets of 7-10 reps. Normal breathing control was interspersed between each set. (Fig 3b.)
d) Pursed Lip Breathing Exercises: The subjects were in sitting position. They were instructed to take deep breaths through the nose and exhale by pursing their lips. An exhalation longer than inhalation was encouraged to be performed. 3 sets of 10 reps with a break in between to avoid hyperventilation. (Fig 3b.)

The total duration of the treatment was around 30 minutes. All the patients were treated twice daily for 7 days i.e., 14 sessions in total.

Group B: Matrix Rhythm Therapy *(Figure 4)*

This group was given routine chest physiotherapy twice daily, as mentioned above. Two additional sessions of MaRhyThe© were added with a gap of two or more days between each consecutive session.

Matrix Rhythm Therapy

Matrix Rhythm Therapy was applied by an electrically operated oscillator (resonator) consisting of a logarithmic spiral-applicator. The treatment area was exposed and talcum powder was applied to reduce friction. The therapist used a longitudinal stroking technique with either a piston grip or a cylindrical grip during the treatment. The intensity of the MatrixMobil® *(Figure 1a)* was adjusted by altering the pressure applied to the head and rotating the apparatus to change the direction or focus of the propagated signal. In case of any soreness, the participant was provided with a hot moist pack for 15 minutes and advised to repeat at home if needed.

The total treatment duration was 45 - 60 minutes.

Treatment areas:

Side-lying: When in a side-lying position, the patient's elbows were flexed, and their hands rested over the plinth. The therapist applied MaRhyThe© over all the intercostal spaces to cover the intercostal musculature.

Supine: When the patient was in a supine position, they were in a crook lying position, and the therapist covered all intercostal spaces anteriorly. Additionally, the therapist covered the diaphragm. For female patients, the therapist lifted the breast tissue and applied Matrix over the thoracic region. In females, the breast tissue was lifted and Matrix was given over the thoracic region.

Prone: When the patient was in a prone position, the therapist covered the ANS system along with the intercostal spaces between both scapulae.

These areas were treated to achieve optimal therapeutic results.

OUTCOME MEASURES

1) Sputum Induction to assess secretion clearance

Sputum induction was performed in accordance with ERS guidelines,[15,16] with premedication using a bronchodilator for safety and comfort. A concentrated saline solution was used via nebulizer, and, the participant instructed to inhale for 15-20 minutes and expectorate every five minutes. Sputum sample was collected and measured in grams, and all details were documented for further analysis.

2) Pulmonary Function Tests (PFT) for assessing lung function (ICC: 0.890)

The ATS recommendations were followed for administering pulmonary function testing, with a portable spirometer *(Figure 2b)* that complies with the ATS/ERS 2019 guidelines for spirometry. [4,17] The participant was seated comfortably and instructed on the procedure. Three measurements were taken, and the best one was recorded for the values of % predicted for FEV_1, FVC, FEV_1/FVC ratio, and PEFR. By using standardized procedures and advanced equipment, the participant's lung function parameters were accurately measured, and this information was useful in evaluating respiratory health and making appropriate treatment recommendations.

3) Thoracic Expansion to assess chest wall excursion and mobility (ICC: 0.95)

The extent of chest expansion was quantified using a non-stretchable inch tape at three levels: axillary, nipple, and xiphisternal. The participants were instructed to stand upright with their hands resting on their hips or sit with their hands behind their heads. They were asked to inhale and exhale completely and maximally, and two measurements were taken at each level. The difference between measurements was recorded for analysis. [18,19]

Results

The present study titled "Effect of Matrix Rhythm Therapy (MaRhyThe©) on Bronchial Hygiene: A Pilot Randomized Control Trial" included 30 participants, randomized into two groups. Group A was control group that received conventional therapy and Group B received Matrix Rhythm Therapy in addition to the conventional therapy. Results in both the groups were compared on the basis of three outcome measures, namely, sputum induction to assess sputum clearance, spirometry to assess lung function, and thoracic expansion to assess thoracic excursion and mobility.

Statistical Analysis

The Statistical Package of Social Sciences (SPSS) version 28 and Microsoft Excel 2013 version 16.0 were used to execute the statistical analysis. The demographic data is presented as mean±SD. Normality of the data was assessed using the Shapiro Wilk test. The pre and post-test analysis of the same group, i.e. within group was carried out using paired t-test for the parametric variables and Wilcoxon signed rank matched pairs test for the non-parametric variables. Whereas, the intergroup comparison or comparison between two groups to know which was better among the two, an independent t-test (unpaired t-test) was used for parametric variables and Mann Whitney U test for the non-parametric variables. *p-value* < 0.05 was considered significant. An effect size analysis was performed by Cohen's d for parametric data and for non-parametric data it was denoted by 'r'.

The demographic characteristics of participants in both the groups, age, gender, height and BMI were homogenously distributed and no significant difference was noted in both the groups ($p > 0.05$) *(Table 1, Table 2)*.

Within group analysis of outcome measures indicated a statistically significant difference in sputum clearance (p <0.001), % predicted FEV1, % predicted FVC, PEFR, and % predicted PEFR (p <0.001) and at all three levels of thoracic expansion, axillary (p = 0.002), nipple (p = 0.001) and xiphisternal level (p <0.001), whereas % predicted FEV1/FVC ratio was not significant within both the groups (p = 0.235) There was reduction in the sputum quantity post treatment in both the groups. The PFT values also showed characteristic improvement. % predicted FEV1, % predicted FVC, PEFR, % predicted PEFR all showed an increase in their respective post-intervention values as

compared to the pre-intervention values in both the groups. Thoracic mobility and excursion values also increased and showed higher values at all three levels post interventions in both the groups. *(Table 3)*

Between group analysis favored Group B in terms of reduction of sputum quantity ($p = 0.013$), and improving thoracic expansion ($p < 0.001$) over Group A indicating Matrix Rhythm Therapy as a better treatment approach as compared to conventional therapy alone. But there was no statistical significance noted in the PFT parameters suggesting both groups were equally effective in terms of improving PFT values. The *p* values for % predicted FEV1, For % predicted FVC, % predicted FEV1/FVC ratio, PEFR and % predicted PEFR were 0.080, 0.97, 0.694, 0.418 and 0.715 respectively. *(Table 4)*

Discussion

The current study evaluated the impact of MaRhyThe© on bronchial hygiene on three parameters, namely, sputum clearance, lung function and chest expansion. The results inferred from the study demonstrated that, 2 sessions of Matrix Rhythm Therapy in collaboration with the existing conventional treatment helps in improving certain lung function parameters, reducing secretions and increasing thoracic expansion.

Demographic profile of the present study indicated a prevalence of chronic respiratory diseases among individuals aged 43-65 years, which is in consensus with existing literature on the age group most susceptible to developing these conditions i.e. 28-64 years (46.1±18.1). [20] Accordingly, our present research also shows the average age of the participants in a manner that is comparable to that of the existing literature.

The treatment strategies chosen under the conventional groups in our study have been proven successful in managing patients with pulmonary ailments, as shown by previous research.[5,13,14,21,22] Several papers have examined multiple procedures over different time frames. But the duration of our protocol was determined considering the average day of discharge from hospitals. By doing so, we aimed to ensure that our protocol is both practical and efficient in the context of a hospital setting, where patient turnover can be high.[23]

Effective airway-clearance mechanisms involve rapid expiratory muscle contraction, sufficient wall shear stress, dynamic airway compression, and an efficient cough or huff. People affected with chronic respiratory diseases display a wide range of pathomechanical issues like altered respiratory biomechanics, impaired airway clearance, reduced respiratory muscle strength, etc. In this study, we hypothesized that increased mechanical forces caused by the micro-vibrations would aid in clearing secretions. Microvibrations occur naturally in the skeletal muscles of the human body. The body's vascular and lymphatic system are controlled by these tiny vibrations that take place in the skeletal muscle, which is vital for preserving a healthy cell environment. Any interruptions in these micro-vibrations can cause an alteration in the normal cellular rhythm that leads to an "energy crises" on a microscopic level, which translates into an illness or pathology on a larger scale. The effects found in the present study, suggest that MatrixMobil® induced chest wall oscillations, resulting in momentary increases in airway pressure and airflow, which helped move mucus towards the central airways for clearance. [24,25,26]

The autonomic nervous system of our body is divided into two parts, namely, the sympathetic and parasympathetic divisions. With respect to the respiratory system, the sympathetic division causes bronchodilation and constriction of the pulmonary blood vessels, whereas the parasympathetic division causes constriction of the bronchi and dilation of the pulmonary vasculature.[27,28] The authors expected that the MaRhyThe© intervention given over the posterior thorax, 3 centimeters away from spinous process of T1 – T4 thoracic vertebrae which corresponds to the location of the sympathetic ganglion may have achieved a generalized improvement in the function of organs along the vagus nerve, thereby restoring the sympathovagal balance overall. The improvements seen in the thoracic expansion and PEFR can be attributed to be secondary to bronchodilation caused by the effect of ANS.[7]

A study conducted by Taspinar et al, reported that Matrix Rhythm Therapy lead to an increased amount of blood flow through the arteries, along with increased arterial diameters and blood velocity. These recordings were done by a color Doppler ultrasound.[29] These findings, extending to our study, may have caused arterial dilatation, thereby improving oxygen exchange and leading to a better ventilation that might have helped improve the lung function parameters, though not statistically significant, the clinical difference was noted.

Breathing exercises form a fundamental and core component of any pulmonary physiotherapists' practice. When integrated into the overall medical treatment plan, they can effectively alleviate symptoms and enhance QOL remarkably. Practicing PLB has been demonstrated to reduce airway resistance, collapse, and dynamic hyperinflation thereby decreasing the mechanical load on muscles, reducing WOB and ultimately improving ventilation and providing relief from dyspnea.[30] However, for an impactful, sustainable and a SSD to be noted, it has been stated that PLB training for at least 8 weeks and diaphragmatic or combined breathing training for at least 4 weeks is required. [31]

The authors' view is the application of MaRhyThe could have enhanced the length-tension relationship of the intercostal muscles and diaphragm, resulting in improved breathing mechanics, thoracic excursion, and mobility. This improvement may be attributed to the rhythmic movements of MaRhyThe, which likely release tension in soft tissues and stimulate the Golgi tendon organs through the sensory system. This process appears to enhance proprioception and increase the flexibility of adhered fibers, which is comparable to the effects of manual therapy.[32]

Current vibromassage and other techniques like kneading, and myofascial release therapies for skeletal muscles focus on trigger points to provide temporary relief through improved blood flow. However, these techniques have limited effectiveness as they only reach a certain depth in the body and require higher frequency. Matrix Rhythm Therapy utilizes lower frequencies to treat deeper tissues by modulating pressure variations perpendicular to muscle fibers. This impacts vascular structures' milking mechanism, resulting in more profound effects on tissues, leading to positive results in studies. All of these mechanisms combined have contributed to the positive results seen in our study.[8,9]

In our study, improvements were not seen in a few of the PFT parameters like the ratio. One of the possible reasons could be the short duration of our intervention session. As per a study conducted which showed positive effects of breathing exercises on respiratory function and exercise capacity, the intervention carried out was for 8 weeks before a SSD was noted in the PFT values.[33] Our study findings are in corroboration with another study that gave interventions for a period of four weeks and found noteworthy improvement in all the parameters except PFT values (FEV_1) indicating a need for long term rehabilitation for improving those outcomes.[34]

The Matrix Rhythm Therapy device functions at a frequency range of 8 to 12 Hz, which is thought to align with the natural vibration frequency of muscles. This synchronization may contribute to the positive outcomes observed with MaRhyThe©, however, there is insufficient proof to substantiate this claim. No studies have compared MRT with other vibration devices or confirmed this hypothesis. Nevertheless, our current research has indicated that the vibrations produced by MRT can aid in secretion clearance, similar to the vibrations generated by a mechanical chest vibrator. While additional research is necessary to validate these results, they suggest that MRT could be useful in managing conditions that require assistance in secretion clearance.

Our study had certain limitations. The hospital's shorter stay protocols resulted in a higher number of dropouts (>11%). The development of soreness, which was reported by two individuals, was another drawback in our study. The authors suggest the following future scopes. Long term effects of the study can be evaluated. A larger sample size can be chosen to generalise the results. Effects of Matrix Rhythm Therapy on oxygenation status using arterial blood gas analysis or other radiological outcomes can be assessed.

Conclusion

The study conducted on 30 participants demonstrated successful and statistically significant results in both the groups in improving bronchial hygiene. Matrix Rhythm Therapy, a recent technology trend in the branch of physiotherapy is vastly been used by musculoskeletal physiotherapists, but its effectiveness cannot be restricted to certain conditions. This research allows it to be incorporated into pulmonary rehabilitation and supports a better statistical significance when compared with the conventional group in terms of boosting secretion clearance, certain lung functions, and promoting thoracic expansion among individuals with chronic respiratory disorders.

The study was one of its kind to showcase these specific effects and can be included as one of the mainstream therapies that can be utilized in the management of lung diseases and disorders.

Tables

Table 1: Demographic_Distribution Of The Participants

VARIABLES	GROUP A	GROUP B	p-value
Age (years)	56.93 ± 5.99	54.33 ± 11.01	0.431
Height (cm)	158 ± 14.65	153.73 ± 13.34	0.958
Weight (kg)	51.86 ± 8.91	51.97 ± 12.02	0.142
BMI (kg/m^2)	20.94 ± 4.31	21.39 ± 5.51	0.129

Except age, p>0.05, no statistical significance. All other parameters except age normally distributed

Table 2: Distribution According To Gender

GENDER	GROUP A	%	GROUP B	%	TOTAL
MALE	7	46.66 %	8	53.33 %	15
FEMALE	8	53.33 %	7	46.66 %	15
TOTAL	15	100%	15	100 %	30

Group A is control group and Group B is experimental group

Table 3: Within Group Comparison Of Outcome Measures (Pre_And Post-Test Measures)

VARIABLES	GROUP	PRE	POST	*p-value*	EFFECT SIZE
		MEAN±SD	MEAN±SD		
% PRED FEV_1	**GROUP A**	52.07±28.82	74.67±24.01	0.002^{**}	0.95
	GROUP B	49.31±22.28	86.49±25.81	$<0.001^{**}$	1.84
% PRED FVC	**GROUP A**	49.12±29.00	67.24±20.19	0.016^{*}	0.62
	GROUP B	49.49±27.31	80.96±22.14	$<0.001^{**}$	0.86
% PRED FEV_1/FVC	**GROUP A**	108.63±11.90	111.47±13.66	0.334	0.24
	GROUP B	104.48±20.38	107.89±16.29	0.233	0.30
PEFR	**GROUP A**	117.80±58.24	210.93±75.17	$<0.001^{**}$	2.492
	GROUP B	169.26±84.26	260.53±126.13	$<0.001^{**}$	1.51
% PRED PEFR	**GROUP A**	31.31±13.32	53.61±20.22	$<0.001^{**}$	1.96
	GROUP B	43.45±19.21	67.75±29.95	$<0.001^{**}$	1.51

SPUTUM	**GROUP A**	8.66±4.36	0.93±1.79	<0.001**	0.89
	GROUP B	22.13±29.44	2.46±6.41	<0.001**	0.88
AXILLARY EXPANSION	**GROUP A**	0.78±0.24	1.00±0.28	0.002*	0.79
	GROUP B	0.76±0.27	1.40±0.36	<0.001**	0.88
NIPPLE EXPANSION	**GROUP A**	1.04±0.003	1.70±1.34	0.001**	0.83
	GROUP B	1.18±0.34	1.87±0.40	<0.001**	0.88
XIPHISTERNAL EXPANSION	**GROUP A**	0.95±0.38	1.17±0.38	<0.001**	1.49
	GROUP B	1.32±0.60	2.00±0.64	<0.001**	1.70

p<0.05 = statistically significant difference observed

p>0.05 = no statistical significant difference

** =significant ** = highly significant*

FEV_1: Forced Expiratory Volume in 1 second, FVC: Forced Vital Capacity, PEFR: Peak Expiratory Flow Rate, % PRED: % predicted

Table 4: Between Group Analysis Of Pre-Test And Post-Test Outcome Measures

VARIABLES	CONTROL GROUP	EXPERIMENTAL GROUP	MEAN DIFFERENCE	*p-value*	EFFECT SIZE
SPUTUM	7.73±3.44	19.66±23.34	11.93	0.013*	0.45
%PRED FEV_1	22.60±23.67	37.17±20.20	14.57	0.080	0.662
%PRED FVC	18.12±23.82	31.51±15.83	13.38	0.97	0.30
% PRED FEV_1/FVC	22.48±10.16	24.30±16.07	1.81	0.64	0.72
PEFR	93.13±37.36	91.26±70.96	1.85	0.418	0.14
%PRED PEFR	22.48±10.16	24.30±16.07	1.81	0.715	0.13
AXILLARY EXPANSION	0.21±0.14	0.63±0.30	0.42	<0.001**	0.76
NIPPLE EXPANSION	0.30±0.16	0.69±0.31	0.39	<0.001**	1.58
XIPHISTERNAL EXPANSION	0.22±0.14	0.68±0.40	0.83	<0.001**	1.53

p<0.05 = statistically significant difference observed

p>0.05 = no statistical significant difference

** =significant ** = highly significant*

FEV_1: Forced Expiratory Volume in 1 second, FVC: Forced Vital Capacity, PEFR: Peak Expiratory Flow Rate, % PRED: % predicted

FIGURES

Figure 1: Consort Chart

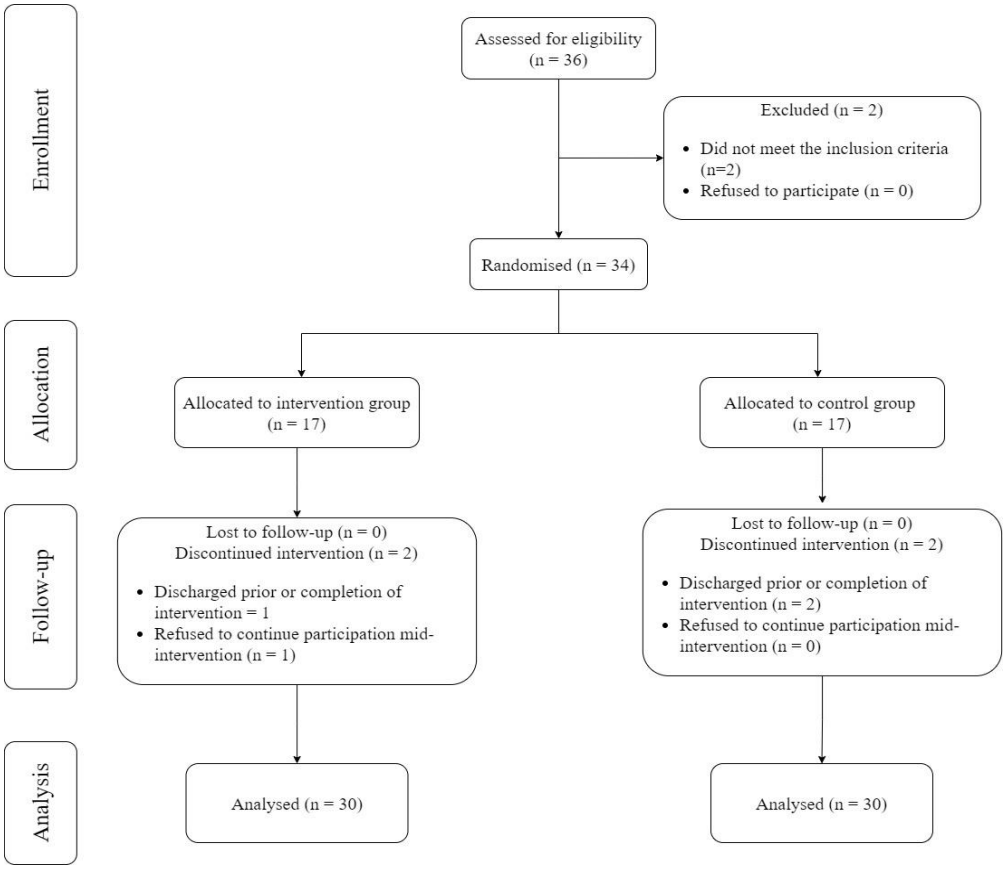

Figure 2: Tools And Equipments

2a. Matrixmobil® and talcum powder

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2b. Portable Spirometer by Spirobank Smart

Figure 3: Conventional Treatment Group

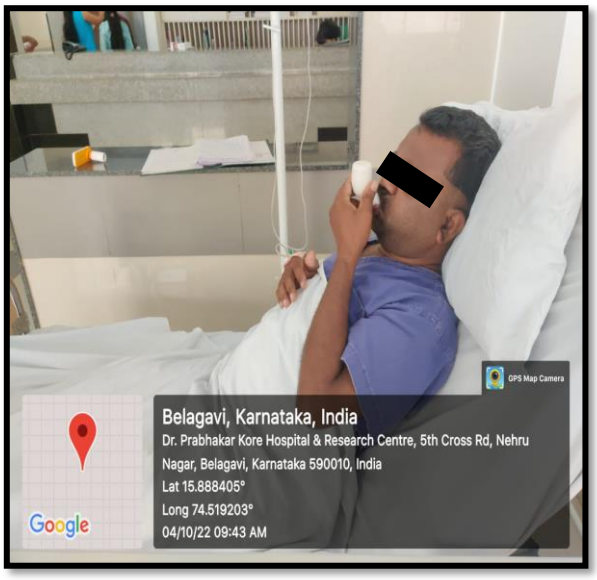
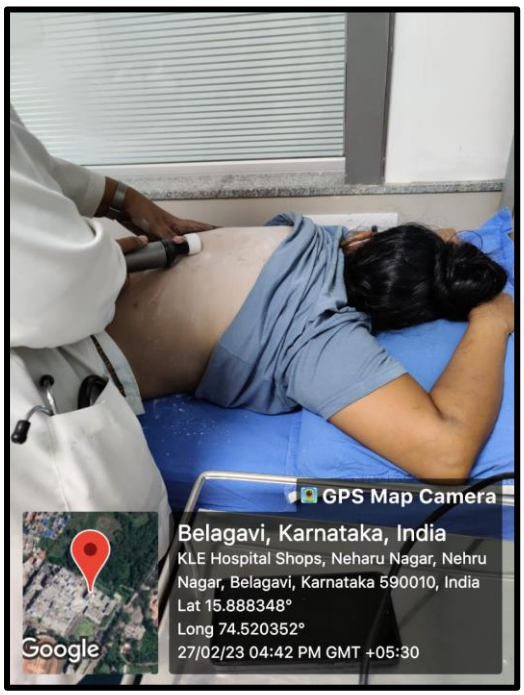


Fig 3a.
FLUTTER

Fig 3b. BREATHING EXERCISES

Figure 4: Experimental Treatment Group



MATRIX RHYTHM THERAPY

Author Contributions:

SK: Literature search, data collection / acquisition, data analysis, statistical analysis, manuscript preparation.

VN: Conceptual designing of the study, definition of the intellectual content, manuscript review and editing.

Conflict Of Interest Declaration:

The authors declare that they have no conflict of interest

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