RESEARCH PAPER

Study of Breathing Exercises on Pulmonary Capacity in Women Cooking on Biomass Fuel

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ABSTRACT

Backround: Smoke exposure from biomass fuels is a serious public health issue, particularly in rural homes. Because they spend a lot of time close to the cooking area, women are most impacted. where coal, wood, dung, and agricultural waste are frequently utilised for cooking. Chronic coughing, dyspnoea, and a higher chance of developing respiratory conditions like COPD are all linked to prolonged exposure to biomass smoke. Particulate matter, carbon monoxide, and other dangerous contaminants are present in the smoke. Lung function is frequently evaluated using metrics including forced vital capacity, forced expiratory volume in one second, and peak expiratory flow rate. One easy physiotherapy method for increasing lung capacity is breathing exercises. Therefore, I it is important to study the effect of breathing exercises on pulmonary capacity in women cooking on biomass fuel.

Aim of study: The study aims to study of breathing execises on pulmonary capacity in women cooking on biomass fuel.

Procedure: Women who cooked on biomass fuel were chosen based on inclusion criteria; a digital spirometer was used to measure the Borg scale, FVC, FEV1, and PEFR at baseline; breathing exercises (diaphragmatic breathing, pursed lip breathing, and forced expiratory technique) were administered for four weeks; and a post-treatment evaluation was conducted to compare pulmonary capacity before and after intervention.

Result: The study comprised 55 women who cooked using biomass fuel. A digital spirometer was used to test pulmonary capacity both before and after four weeks of breathing exercises. The average FVC rise from 2.01 L to 2. 36 L, PEFR rise from 4.64 L to 5.43 L during therapy, and FEV1 increased from 1.62 L to 1.95 L. The improvement in FVC, FEV1, and PEFR following breathing exercises was statistically significant ($p<0.05$), according to statistical analysis using the paired t-test.

Conclusion: The current study found that women who cook with biomass fuel can improve their lung capacity by engaging in breathing exercises. FVC, FEV1, and PEFR values significantly improved after four weeks of diaphragmatic breathing, pursed lip breathing, and forceful expiration technique. Frequent breathing exercises enhance respiratory function and lessen the negative effects of biomass smoke on the lungs.

KEYWORDS: Breathing exercises, Pulmonary capacity, Biomass fuel, Digital, Spirometer, Respiratory function, Borgs scale.

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INTRODUCTION

Approximately 2.4 billion people reside in homes that use solid biomass fuels for heating and cooking. Typically, wood, charcoal, dried animal manure, and agricultural waste like straw and sticks are used as solid biomass fuels. Particularly in rural areas of developing nations, the smoke emissions from these fuels are a significant source of indoor air pollution. These emissions include gaseous pollutants like formaldehyde and carbon monoxide, as well as significant pollutants that have a negative impact on health, including benzopyrene. The lungs can be deeply penetrated by particles having a diameter less than 10 µm (PM10), especially those with a diameter less than 2.5 µm (PM2.5). In rural areas, 90% of households use a biomass stove to prepare their meals. Women who prepare meals for families in remote communities are most commonly impacted; their health is harmed by frequent and extended exposure to these dangerous contaminants.

Exposure to emissions from biomass fuels is likely one of the biggest occupational health risks for women in underdeveloped nations. Fine particulate matter-formed smoke is released when combustion is incomplete. Significant amounts of smoke particles and gaseous products are produced by combustion, particularly when burning is inefficient, and frequently there is no external exhaust. Indoor air pollution can be quite bad if there is inadequate ventilation, as is frequently the case. Over two-thirds of households worldwide reside in developing nations, with roughly three-quarters of them being in rural areas. Huts in rural settlements are therefore the most common indoor environment today, as they have been for the majority of human history.

Achieving the objective of universal health by the year 2000 requires reducing the health risks connected with the widespread use of biomass fuels. Air pollution sources and emissions: Cooking stoves can be categorised in a variety of ways. It would be reasonable to group some questions according to efficiency, building material, or the number of pots that can be set on them. The categories pertaining to the combustion chamber's design may be the most appropriate in terms of smoke emissions. Despite the wide range of variations, four models appear to be particularly noteworthy:

Open combustion, which does not use a combustion chamber. The most typical illustration of this kind is a pot supported by three rocks or bricks over an open flame. The impoverished in every country use this system because it is clearly the least expensive. Open combustion in part. A semi-enclosed combustion chamber can be made by creating a U-shaped hole in a block of clay or bricks, or by excavating a small pit in the ground. A flue-free enclosed chamber. These stoves, which are either buried in the ground or constructed of clay or metal, feature an enclosed combustion chamber but no chimney to remove smoke or create natural airflow.

A vast variety of elements in various physical forms make up biomass fuels. In addition to dried manure from large animals like cattle, buffalo, and camels, crop wastes including cotton stalks, oilseed stalks, rice straw, and coconut husks also contribute significantly. Cacti, weeds, scrub plants, and other diverse biomass sources are also utilised. Wood has, of course, always been the most significant form. However, the category of fuelwood is equally diverse. As with samples from other species, logs, branches, bark, twigs, and leaves all have somewhat distinct chemical and physical properties. Smoke inhalation and carbon monoxide poisoning both have acute health effects and can be fatal if high enough amounts of the gas are present in the air that is breathed. The pollutants' irritating or inflammatory effects on the conjunctiva and the mucous linings of the respiratory system, which extend from the nose to the bronchi, cause subacute consequences. Among the significant hydrocarbons with an irritating effect are a number of contaminants found in emissions from biomass fuels, including toluene, phenols, and aldehydes.

Exposure to biomass fuels has been linked to a number of respiratory illnesses. Asthma, pulmonary tuberculosis (TB), lung cancer, interstitial lung disease (ILD), acute respiratory infections (ALRI), and chronic obstructive pulmonary disease (COPD) all have varying degrees of connection. The risk of respiratory diseases, particularly COPD, is increased by exposure to biomass smoke [1, 2, 3, 4]. Chronic indoor smoke exposure from burning biomass fuels has been linked to the development of COPD in 35% of patients [3].

Airflow restrictions in COPD, an inflammatory disease, are typically progressive and not entirely reversible. Systemic or extrapulmonary factors are mentioned, as is the part that exposure to harmful particles or gases plays [5]. Three interconnected pathways define pathological COPD: Airspace enlargement and loss of elastic recoil are caused by remodelling of the tiny airway walls, loss of small airways, and alvelolar structure degradation.

Reduced diameter and increased resistance are the results of fibrosis, smooth muscle cell proliferation, and the immigration of inflammatory cells into the small airways [6]. High quantities of reactive oxygen species (ROS), which are also present in biomass smoke, are releasedby these cells in COPD. Protease such neutrophil elastase an matrix metalloproteinase can then be activated by this process, which further increases the influx of inflammatory cells. As a result, oxidative stress, protease imbalance, and airway inflammation. In patients with COPD, lung pathology includes fibrosis, occlusion, loss of tiny airways, parenchymal damage, and thickening and hypersecretion of mucus.

These pathological changes and exposed to mixed fuel manifested as symptoms associated with airflow limitation such as coughing, wheezing, and shortness of breath [1,3,7].

COPD-related inflammatory alterations linked to aberrant airway function. In healthy people, the resistance of a tiny airway with an interior diameter of less than 3 mm accounted for 24–33%, whereas in people with COPD, it accounted for 50–56%. Uneven expiratory flow results from a quicker loss of elastic recoil during expiration. exposed to fuel made from biomass. In patients with COPD, an increase in total lung capacity is commonly seen. Loss of lung elastic recoil has been linked to TLC, which is the lung volume at which the respiratory system's recoil pressure and the inspiratory muscle's force are balanced [8,9].

The basic function of the lung is to facilitates gas exchange from the environment to the bloodstream, Oxygen gets transported through the alveoli into the capillary network.

The significant lung volumes and their definations as following-

TIDAL VOLUME (TV)

volume inspired and expired with each breath

INSPIRATORY CAPACITY (IC)

Volume that can be breathed after normal exhalation

VITAL CAPACITY (VC)

Maximum volume able to be expired after maximal inspiration

FORCED EXPIRATORY VOLUME (FEV1)

Volume that can be expiration in 1 second of maximal forced expiration

TOTAL LUNG VOLUME (TLV)

Air held by the completely filled lungs [10]

Tidal volume (TV)- The small up and down waves that is the normal breathing (air you inhale and exhale in relaxed position).

Forced Vital Capacity (FEV)- The big peak and drop – The maximum air you can forcefully exhale after taking a deep breath.

Forced Expiratory Volume in 1 second (FEV1)- The portion of air exhaled in the first second.

Biomass smoke has been shown to consist of over 200 different compounds, which includes a significant number of toxic compounds. As following [7].

Domestic smoke pollutants and possible mechanics for potential health effects- [11]

The type of fuel, the population at risk, and the local context all influence the type and severity of the health risks associated with emissions from biomass fuels. People's living conditions, culture, and habits have a big impact on the type and extent of danger. Climate and weather conditions also influence exposure to emissions from biomass fuels since individuals will spend more time indoors in cold, wet weather than in sunny, dry weather. Women who cook as well as infants and children will be affected. Breathing exercises have been an essential part of comprehensive rehabilitation programs for COPD patients [4].

Many breathing techniques, such as diaphragmatic breathing, active expiration, pursed lip breathing, relaxation breathing, and ventilator feedback training, have been suggested to enhance respiratory muscle function and quality of life in patients with COPD [12].

It is

possible to screen for undiagnosed COPD using expiratory flow meter devices [13].
The pulmonary capacity of the lungs reflects their capacity to exchange gases, ventilate, and supply oxygen to the body. Long-term smoking exposure can damage the lungs, which can lead to a reduction in oxygen intake, an increase in dyspnoea, and a decline in physical performance. Because years of exposure might accelerate functional decline and raise long-term morbidity, women are particularly susceptible to this issue.
Breathing exercises including pursed-lip breathing, diaphragmatic breathing, and structured yoga practices like pranayama are commonly used as non-pharmacological therapy in pulmonary rehabilitation programs.Increasing lung volumes and capabilities, enhancing ventilation, and strengthening the respiratory muscles are the goals of these exercises. In patients with chronic respiratory conditions, structured breathing exercise regimens have been shown to improve inspiratory muscle strength and functional respiratory outcomes in clinical settings. For instance, it has been demonstrated that following consistent practice, diaphragmatic and feedback breathing exercises considerably improve participants' functional vital capacity and other spirometric measures.In pulmonary rehabilitation programs, breathing exercises such as diaphragmatic breathing, pursed-lip breathing, and structured yoga poses like pranayama are frequently employed as non-pharmacological therapy.These workouts aim to strengthen the respiratory muscles, improve ventilation, and increase lung volumes and capacities. Structured breathing exercise programs have been demonstrated in clinical settings
to enhance inspiratory muscle strength and functional respiratory outcomes in individuals with chronic respiratory diseases. For example, diaphragmatic and feedback breathing exercises have been shown to significantly increase participants' functional vital capacity and other spirometric measurements after regular practice.

METHODOLOGY

An Interventional, Clinical study conducted at At-Chandre, Tal-Radhanagari, Dist- kolhapur on Women cooking on biomass fuel. The study was done by using Simple random sampling that is Probability sampling. After getting Ethical clearance from the institutional ethics committee the study was initiated. For a duration of 6 Months. The sample size was 55**.** All the study subjects were selected fulfilling exclusion and inclusion criteria. Written informed valid consent was taken from all participants.

Inclusion Criteria

Gender – Females, age - 35 years old onwards, population - women cooking on biomass fuel, Years of cooking on biomass fuel – More than 11 to 20 years, women who are exposed to biomass fuel are willing to be participate

Exclusion criteria

If the patient have chest trauma, pulmonary fibrosis, interstitial lung disease

PROCEDURE

The study protocol was presented before the Institutional Ethical Committee and Protocol Committee of D.Y. Patil University, Kolhapur.

Subjects were selected from Chandre, Taluka Radhanagari, District Kolhapur according to the inclusion criteria and were informed about the study.

The procedure was explained to the subjects, and written consent was obtained from those who were willing to participate.

There was one group consisting of 55 individuals.

Demographic data such as age, years of cooking, and hours of cooking were recorded as per the data collection sheet along with outcome measures.

Pre-intervention values were recorded using a digital spirometer and Borg scale.

The intervention consisted of three sessions per day for four consecutive weeks.

All participants were given breathing exercises such as pursed lip breathing, diaphragmatic breathing, and the forced expiration technique. Each session lasted 10 to 15 minutes and included three sets.

Post-intervention values were recorded using a digital spirometer and Borg scale after four weeks of breathing exercises.

PURSED LIP BREATHING EXERCISE

An essential part of pulmonary rehabilitation is breathing exercises. Diaphragmatic breathing (DB) and pursed lip breathing (PLB) are two strategies that are crucial to the management of COPD. By lowering resting respiratory rate, raising tidal volume and oxygen saturation, and minimising recovery time to pre-exercise breathlessness levels, pursed lip breathing helped patients. Patients with COPD found that pursed lip breathing during exercise reduced their respiratory rate and minute ventilation. In patients whose respiratory muscle system is intact, diaphragmatic breathing may enhance breathing pattern and ventilatory efficiency without producing dyspnoea. COPD patients with decreased tidal volumes and increased respiratory rates [14].

PATIENT POSITION- Be in an upright positon such as sitting or standing

NUMBER OF REPETITIONS – Repeat of 6 times with pause of 2 seconds per repetition [15].

PROCEDURE

The patient should be standing with their neck and shoulder muscles relaxed. Close your mouth and take a slow, two-second breath in via your nose. Counting to yourself might be beneficial. Breathe out all of the air in your lungs slowly while keeping your mouth shut and your lips pursed, "as if you were going to whistle or gently flicker the flame of a candle, for at least 4 seconds." Counting to yourself might be beneficial. Don't push the air out. It is recommended to take twice as long to exhale as to inhale. Breathe with your lips pursed until your breathing returns to normal [16].

DIAPHRAGMATIC BREATHING EXERCISE

Diaphragmatic breathing (DB) can enhance ventilation distribution, reduce dyspnoea and breathing effort, and rectify aberrant chest wall motion. The usage of supplementary breathing muscles by COPD patients significantly increases the effort required to breathe. Teaching COPD patients to relax their accessory breathing muscles and utilise more diaphragmatic breathing to lessen breathing effort and improve ventilation and dyspnoea is a typical objective of breathing retraining [17].

PATIENT POSITION- Half –lying or sitting position

NUMBER OF REPETITIONS- Three sets of 15 to 20 repetitions [18].

PROCEDURE

With their head and back properly supported and their abdominal wall relaxed, the patient should be sitting up straight. If slightly extending the knees in bed helps the abdominal wall relax (as long as it is removed after treatment), a little pillow may be employed. A chair with a high back and no armrests is ideal for teaching breathing exercises outside of bed. To feel movement, place your hands on the anterior costal margins and upper abdomen. Start by softly exhaling while letting your shoulders and upper chest relax. Then, feel your lower ribs sink down and in toward your midline. The front costal edges will shift up and out, and the upper abdomen will slightly protrude forward [19].

FORCED EXPIRATION TECHNIQUE (FET)

It has been demonstrated that the forced expiration method improves bronchial secretion clearance efficiency without inducing or exacerbating bronchospasm. The patient shouldn't feel worn out and there shouldn't be any increase in airway blockage when the method is properly taught with relaxed diaphragmatic breathing in between huffs.

PATIENT POSITION- Sitting position

NUMBER OF REPETITIONS- 2 Huffs at low volume, 3 Huffs at high volume [20].

PROCEDURE

A period of comfortable diaphragmatic breathing should be followed by one or two huffs from mid-lung volume while the patient is in a relaxed position. After inhaling, the patient exhales strongly via the mouthpiece, while clenching the muscles of their chest wall and abdomen, as breathing out with a partially closed glottis does not result in an effective huff. A huff or cough from a large lung capacity will remove secretions from the upper airway [21].

RESULTS

Age and Years of cooking on biomass fuel

Table 1: Age and years of cooking on biomass fuel

Variables	Minimum	Maximum	Mean	Std. Deviation
AGE	36	70	49.85	10.86
YEARS OF COOKING ON BIOMASS FUEL	12	40	22.40	7.33

Participants' Age and Years of Cooking with Biomass Fuel: Descriptive Statistics. The descriptive statistics of the study participants are displayed in the table. The majority of participants were middle-aged women, with ages ranging from 36 to 70 years, with a mean age of 49.85 ± 10.86 years. With a minimum of 12 years and a maximum of 40 years, the average cooking time on biomass fuel was 22.40 ± 7.33 years. This suggests that the individuals were exposed to biomass fuel smoke for an extended period of time, which could have an impact on their lung health. These demographic traits aid in comprehending the study population's history and degree of exposure.

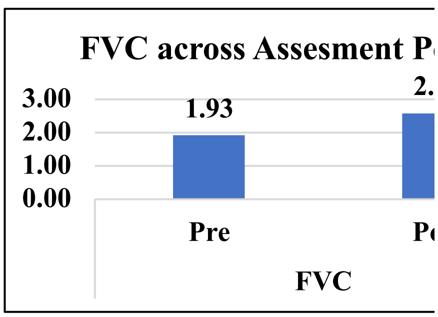
B. The table shows that breathing exercises significantly improved pulmonary function (FVC, FEV_1, and PEFR) with highly statistically significant results ($p < 0.001$).

DIGITAL SPIROMETER	Assesment Period	Mean	Std. Deviation	p-value
FVC	Pre	1.93	0.87	

	Post	2.58	0.72	<0.001*
FEV 1	Pre	1.78	0.63	<0.001*
	Post	2.25	0.67	
PEFR	Pre	3.92	0.79	<0.001*
	Post	4.93	0.54	

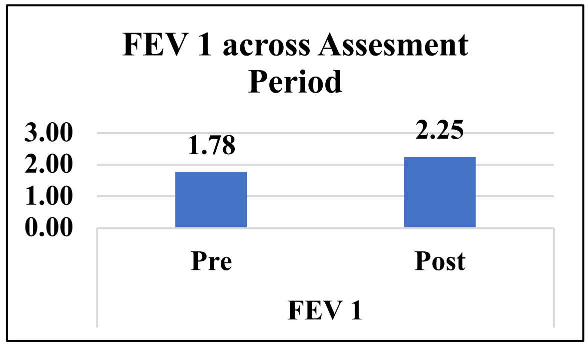
Table 2- Breathing exercises significantly improved pulmonary function (FVC, FEV_1, and PEFR) with highly statistically significant results ($p < 0.001$).

All pulmonary indicators improved statistically significantly following the intervention, according to the examination of the digital spirometer values. The FVC mean increased from 1.93 ± 0.87 (before) to 2.58 ± 0.72 (post). Similarly, PEFR rose from 3.92 ± 0.79 to 4.93 ± 0.54, and FEV_1 improved from 1.78 ± 0.63 to 2.25 ± 0.67.
The breathing exercises significantly improved pulmonary capacity, as evidenced by all measures showing a very significant change with p-values <0.001.



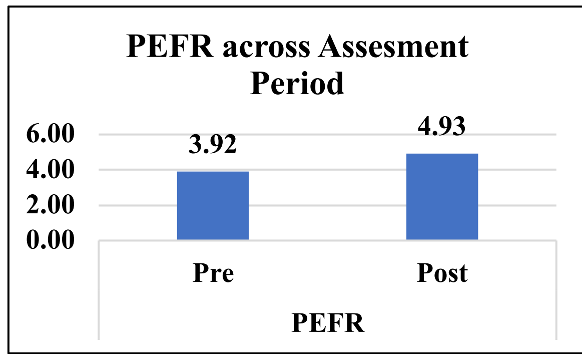
Graph 1- Pre And Post Values Of Forced Vital Capacity

Graph 1 shows graphical representation of pre and post values of Forced Vital Capacity. Pre value of FVC across Assesment Period is 1.93 and After Breathing Exercises i.e- Post Value of FVC across Assesment is 2.58.



Graph 2- Pre And Post Values Of Forced Expiratory value in 1 sec.

Graph 2 shows graphical representation of pre and post values of Forced Expiratory value in 1 sec . Pre value of FEV1 across Assesment Period is 1.78 and After Breathing Exercises i.e- Post Value of FEV1 across Assesment is 2.25.



Graph 3- Pre And Post Values Of Peak Expiratory Flow Rate.

Graph 3 shows graphical representation of pre and post values of Peak Expiratory Flow Rate. Pre value of FEFR across Assesment Period is 3.92 and After Breathing Exercises i.e- Post Value of PEFR across Assesment is 4.93.

C. **The table shows a significant reduction in Borg Scale scores after the intervention, indicating decreased breathlessness ($p < 0.001$).**

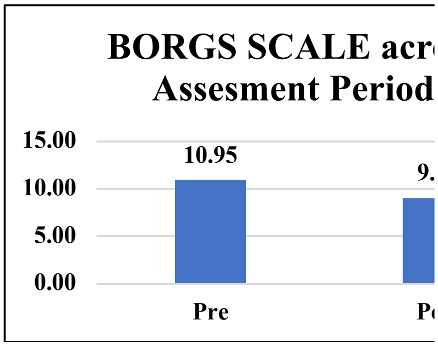
Table-Significant reduction in Borg Scale scores after the intervention, indicating decreased breathlessness ($p < 0.001$).

The Borg Scale scores obtained before (pre) and after (post) the intervention are compared in the table.

BORGS SCALE	Mean	Std. Deviation	p-value
Pre	10.95	2.61	<0.001*
Post	9.02	2.44	

People's perceived level of effort or dyspnoea is measured using the Borg Scale.
The mean Borg score was 10.95 ± 2.61 prior to the intervention and dropped to 9.02 ± 2.44 following it. This decrease in mean score suggests that after the intervention, participants had less dyspnoea.

A very statistically significant difference between pre- and post-intervention scores is shown by the comparison's p-value of less than 0.001.



Graph 4- Pre And Post Scores Of Borgs Scale.

Graph 4 shows graphical representation of pre and post Scores of Borgs Scale. Pre Scores across Assesment Period is 10.95 and After Breathing Exercises i.e- Post Scores of Borgs Scale across Assesment is 9.02.

DISCUSSION

The current study assessed how breathing exercises affected the pulmonary capacity of women who were cooking with biomass fuel. Solid biomass fuels are used for cooking and heating in the households of almost 2.4 billion people. Solid biomass fuels often include wood, charcoal, dried animal dung, and agricultural waste such as sticks and straw. These fuels' smoke emissions are a major cause of indoor air pollution, especially in rural parts of poor countries. These emissions include major pollutants that are harmful to health, such as benzopyrene, as well as gaseous pollutants like formaldehyde and carbon monoxide.

Ninety percent of households in rural areas cook their meals on biomass stoves. The majority of those affected are women who cook for families in isolated areas; regular and prolonged exposure to these harmful pollutants is detrimental to their health. Women who cook with biomass fuel are constantly exposed to indoor air pollutants such carbon monoxide, particulate matter, and other dangerous gases, which have a negative impact on respiratory health and eventually cause lung function to decline [1,2].

Increased respiratory discomfort, airway inflammation, and reduced pulmonary efficiency are frequently the outcomes of this long-term exposure. Such deteriorated lung state is reflected in the study's baseline (pre-intervention) data. The study's sample consisted of 55 women who cooked with biomass fuel and were at least 35 years old. Their exposure to biomass fuel ranged from 11 to 20 years. The subject will be assessed twice: once before training and once after (four weeks). All outcome measurements will be evaluated on a single day, and the exercise regimen will start on the same day using the Borgs scale and digital spirometer.

After breathing exercises were applied, there was a statistically significant increase in FVC, FEV_2, and PEFR. The improvement in FVC indicates increased lung expansion and enhanced ventilatory capacity. The increase in FEV_2 implies better airway patency and reduced airflow resistance, but the rise in PEFR shows increased expiratory muscle strength and airway clearance. These changes all indicate an overall improvement in lung function. There is little empirical evidence that breathing exercises are especially helpful for women who are exposed to smoke from biomass fuels, despite the fact that they have been studied in both general populations and patients with respiratory disorders. Increased pulmonary capacity can help women who cook at home experience less dyspnoea, be more productive at work, have greater physical stamina, and more productivity at work, more physical stamina, and an improved quality of life.

With a minimum of 12 years and a maximum of 40 years, the average cooking time on biomass fuel was 22.40 ± 7.33 years. This suggests that the individuals were exposed to biomass fuel smoke for an extended period of time, which could have an impact on their lung health. The results showed a decrease in perceived dyspnoea as determined by the Borg Scale after the intervention, as well as a significant increase in pulmonary function indicators, such as FVC, FEV_2, and PEFR. The Borg Scale scores' decline, which shows that participants' perceptions of dyspnoea have lessened, provides additional evidence of the intervention's efficacy. The objective improvement in lung function measurements is consistent with this reduction in subjective symptoms.

FEV1 was 1.78 prior to the assessment period and following breathing exercises. For example, the post-value of FEV1 across assessment is 2.25. The before and post values of the peak expiratory flow rate are represented graphically in Graph 3. Following breathing exercises, the pre-value of FEFR throughout the assessment period is 3.92. For example, the PEFR Post Value across Assessment is 4.93. The mean Borg score was 10.95 ± 2.61 prior to the intervention and dropped to 9.02 ± 2.44 following it. This decrease in mean score suggests that after the intervention, participants felt less dyspnoea. The particular breathing techniques employed in the study are responsible for the favourable results. Pursed lip breathing enhances gas exchange, prolongs expiration, and keeps the airway from collapsing.

Diaphragmatic breathing increases lung expansion, improves diaphragmatic movement, and lessens breathing effort. By facilitating efficient airway clearing and secretion elimination, the forced expiration approach enhances ventilation [25]. These results are in line with earlier research that shown the effectiveness of breathing exercises in enhancing pulmonary function and lessening respiratory symptoms, particularly in individuals with chronic respiratory illnesses or those exposed to environmental toxins. Overall, the study finds that breathing exercises can greatly increase pulmonary capacity and lessen dyspnoea in women exposed to biomass fuel. They are also an easy, affordable, and non-invasive intervention.

This emphasises how crucial it is to include these kinds of activities in community health initiatives in order to support vulnerable groups' respiratory health.

CONCLUSION

Participants' perceptions of dyspnoea were reduced, as evidenced by a significant fall in Borg Scale scores in addition to objective improvements in pulmonary function. This implies that the intervention improved the participants' total respiratory comfort and functional abilities in addition to their physiological lung capacity.

The combination of pursed lip breathing, diaphragmatic breathing, and forced expiration method, which together improve ventilation, optimise breathing patterns, and ease airway clearance, is responsible for the intervention's efficacy.

Thus, it can be said that breathing exercises are an easy, safe, economical, and non-pharmacological way to help women who are exposed to biomass fuel improve their lung health. Reducing respiratory issues and improving the quality of life for this susceptible population can be greatly aided by including these activities into daily routines and community health initiatives.

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