The Effect of Threshold Inspiratory Muscle Training Device and Incentive Spirometry Device for Dyspnoea among Third-Trimester Antenatal Women

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Abstract

Background: During pregnancy, the progesterone hormone causes the respiratory system to increase oxygen consumption. Maternal hyperventilation causes the partial pressure of oxygen to increase and partial pressure of carbon-dioxide to decrease. During the third trimester, the compression of the diaphragm in the lower base of the lungs, which causes dyspnoea.

Purpose: The purpose of the study to find the prevalence and to evaluate the effect of threshold inspiratory muscle training device and incentive spirometry device for dyspnoea among third-trimester antenatal women using modified borg dyspnoea and dyspnea-12 questionnaire.

Materials and Methods: The study analysed prevalence of dyspnoea in third-trimester antenatal women from December 2022 to April 2023 using the dyspnea-12 questionnaire. Out of 77 participants, 15 subjects were excluded due to improper follow-up, lack of participation, and withdrawal from the study. In phase 2, in May 2023, 62 participants were divided into two groups: 31 antenatal women underwent threshold inspiratory muscle training along with diaphragmatic breathing exercises, and 31 underwent incentive spirometry along with diaphragmatic breathing exercises.

Result: Statistically significant differences between the two devices were evaluated by post-values of 13.80 ± 23.20; and the P value is < 0.0001. These values were considered to be extremely statistically significant.

Conclusion: Threshold inspiratory muscle training device is more effective than Incentive Spirometry device for dyspnoea among third-trimester antenatal women.

Keywords: Threshold Inspiratory Muscle Training Device, Incentive Spirometry, Diaphragmatic Breathing Exercises, Breathlessness, Functional Capacity.

Introduction

Pregnancy is a phenomenon in which anatomical and physiological changes begin after conception and have an impact in every system in the body. In the respiratory system, the level of progesterone hormone increases oxygen consumption that raises the minute ventilation. Maternal hyperventilation causes the partial pressure of oxygen to increase and partial pressure of carbon dioxide to decrease.¹
Dyspnoea or shortness of breath is the most common symptom in pregnancy. According to previous study (2019), 60-75 percent of pregnant women experience dyspnoea in third trimester due to appearance of foetal head compressing the diaphragm and being positioned beneath a rib just before the baby starts to turn and sink deeper into pelvis.\(^2,3\) So, the latency of the airway and ability of gas exchange between the alveoli of functional lung capacity, which slightly lowers the blood partial pressure of carbon dioxide levels.\(^4\) Threshold inspiratory muscle training device is a pressure-based type of device, that gives resistance that helps to improve and strengthen the respiratory muscles, and it provides a consistent and specific pressure for the inspiratory muscle for strengthening and endurance training.\(^5-9\) It consists of a spring-loaded valve that provides resistance to generate a load up to 9 cm H\(_2\)O to 41 cm H\(_2\)O. Thus, the purpose of the study was to evaluate the effect of a threshold inspiratory muscle training device is used to strengthening the weakened inspiratory muscles which reduces the dyspnoea and improves pulmonary functions.\(^10-13\) Incentive spirometry, otherwise called as sustained maximal inspiration, is used to raise the transpulmonary pressure and inspiratory volumes, enhancing the function of the inspiratory muscles which activate the typical pattern of hyperinflation. Airway patterns may be maintained and lung atelectasis is prevented. There are two types of spirometry; flow-oriented and volume-oriented spirometry.\(^14,15\) Flow-oriented incentive spirometry device makes you work harder to breathe. It helps to increase the muscles in the upper chest, which has three chambers with one ball in each chamber and a capacity up to 1200 ml to improve only accessory muscles of respiration. Whereas, a volume-oriented incentive spirometry device does not make you work as hard. It has a one-way valve with a capacity up to 5000ml. Current evidence that proves this type of spirometry requires less work of breathing and improves diaphragmatic function and pulmonary function better compared to tri-flow.\(^16,17\) Diaphragmatic breathing exercises are also known as belly or abdominal breathing. It is an important muscle that helps to breathe and also has an effective role for primary muscles of inspiration. Which involves breathing deep into the stomach that helps to strengthen the diaphragm.\(^18\) Using the diaphragm consciously during respiration, increases the lung capacity and alveolar oxygen saturation to improve the efficacy of oxygen ventilation. It has been shown to be beneficial during pregnancy.

### Aim

To find the prevalence of dyspnoea among third-trimester antenatal women and to evaluate The effect of Threshold inspiratory muscle training device and Incentive spirometry device for dyspnoea among third-trimester antenatal women.

### Materials and Methods

This study has been conducted in two phases, from December 2022 to May 2023. The antenatal women were selected based on inclusion and exclusion criteria. The sampling technique was convenient and the sample size was 62 Antenatal women.

#### Inclusion Criteria

1. Antenatal women in the age group of 20-30 years.
2. Moderate to severe dyspnoea by using the dyspnea-12 questionnaire
3. Primigravida women

#### Exclusion criteria

1. Antenatal women who all had high body temperature.
2. Psychiatric disorders.
4. Unstable angina.
5. Not willing to participate.

#### Outcome Measures

**A. Modified Borg Dyspnoea Scale:**

The Modified Borg dyspnoea scale was termed the CR10(category ratio) scale, it indicates 0-10 scores; 0- denotes no exertion score whereas, 10 which is classified by maximal exertion score. Based on various studies, modified Borg dyspnoea scale is a valid and reliable tool to measure dyspnoea.

**B. Dyspnea-12 Questionnaire:**

Dyspnoea 12 questionnaire, is a reliable and valid questionnaire to measure Breathlessness. It is
examined by 12 sets of questions, which are evaluated by components that are mild, moderate, severe. It ranges from 0 to 36, where 0-12 represents mild; 13-24 represents moderate score; at lastly, 25-36 represents severe scoring.

**Study Procedure**

This study has been conducted in two phases. In phase-1 from December 2022 to April 2023, a cohort study was used to determine the prevalence of dyspnoea among antenatal women, which was analysed by the dyspnea-12 questionnaire to collect the data. Before the study started, an informed consent form was given to the participants. The prenatal census which is collected from Saveetha institute of technical sciences in obstetrics and gynaecology outpatient department. 976 antenatal women who have been found as third trimester per month, around 32 third trimester antenatal women came for consultation per day. out of 32 antenatal women, 6 antenatal women were diagnosed with dyspnoea symptoms as determined by dyspnea-12 questionnaire. Therefore, during a period of five months. 756 antenatal women had reported with dyspnoea symptoms which is divided by the total number of pregnant women in the third-trimester. 77 antenatal women had reported with moderate to severe dyspnoea around 20%. As a result, the study has seen only the prevalence in phase-1. In phase 2, an experimental study was conducted in May 2023 a total of 77 antenatal women were selected based on inclusion criteria. In this study, Antenatal women in the age group of 20-30 years, moderate to severe dyspnoea by using the dyspnea-12 questionnaire and primigravida women were included. Antenatal women who all had high body temperature, psychiatric disorders, myocardial infarction, and unstable angina were excluded in this study. Out of 77 antenatal women, 15 women were excluded due to improper follow up, lack of participation, and in between withdrawal from the study. 62 antenatal women underwent phase-2 study. Which is divided into two groups. 31 antenatal women underwent threshold Inspiratory muscle training device along with diaphragmatic breathing exercises, and another 31 antenatal women underwent Incentive spirometry device along with diaphragmatic breathing exercise. Before the treatment, participated women were assessed by antenatal assessment.

Threshold Inspiratory Muscle Training Device and Incentive Spirometry Device for Dyspnoea among Third-Trimester Antenatal Women

1. **Patient Position**: Sitting in a comfortable position.

2. **Therapist Position**: Standing position.

3. **Procedure**: a. Antenatal women held the Threshold Inspiratory Muscle Training over the hands, then increased the pressure from 9 cm H2O to 41 cm H2O. Before beginning the treatment, secure the nose with a nose clip to prevent holding the breath. The antenatal women place their mouth over the mouthpiece, carefully inhale and hold their breath for two to three seconds. This helped the spring load valve provide resistance, which inflates the alveoli to expand in order to receive the oxygen and to prevent hyperventilation. The mouth should be free from the mouthpiece while exhaling.

   b. Volumetric incentive spirometry device has one valve up to 5000 ml which gives visual feedback to the patient. Antenatal women were used to inhale through the mouthpiece so the piston will raise up to the levels and hold it for two to three seconds and the mouth should be free from the mouthpiece while exhaling.

4. **Precautions**: Not encouraged to inhale quickly through the mouthpiece.

5. **Frequency and Duration**: The treatment session was given for five days a week followed by four weeks. The antenatal women underwent diaphragmatic breathing exercises were trained to inhale deeply while holding the breath for up to two seconds and to exhale through the mouth in pursed lip position, for 10 repetitions. Then, the threshold Inspiratory muscle training device and Incentive spirometry device treatment sessions were given for up to 15 minutes, which consisted of 3 sets with 30 repetitions, and 10 seconds rest period in between each set. The pre and post-test values were evaluated by the modified Borg dyspnoea scale and the dyspnea-12 questionnaire.

**Statistical Analysis**

In this study, paired ’t test was used for analysing pre and post-test values of individual groups.
Whereas, unpaired ‘t test’ was used for analysing post-test values of individual groups.

Graph-1 Pre and Post test of modified borg dyspnoea scale in Threshold inspiratory muscle training group using Paired-T test.

Graph-2 Pre and Post test of modified borg dyspnoea scale in Incentive spirometry group using Paired-T test.

Graph-3 Post values of modified borg dyspnoea scale in Threshold inspiratory device and Incentive spirometry using unpaired- T test.

Graph-4 Pre and Post Test of Dyspnea-12 Questionnaire in Threshold Inspiratory muscle training group using Paired- T test.

Graph-5 Pre and Post Test of Dyspnea-12 Questionnaire in Incentive spirometry group using Paired- T test.

Graph-6 Post values of Dyspnea-12 Questionnaire in Threshold Inspiratory muscle training and Incentive spirometry using unpaired- T test.
Result

In Graph-1, The pre- and post-test of modified Borg dyspnoea scale in threshold inspiratory muscle training device group using paired-t test of mean 5.0 ± 1.50; SD 1.8 ± 1.08; P value <0.0001. In Graph-2, The pre and post test of modified Borg dyspnoea scale in Incentive spirometry group using paired-t test of mean 6.60±4.30; SD 0.84 ±1.25; P value <0.0001. In Graph-3, The post values of modified Borg dyspnoea scale in threshold inspiratory muscle training device and incentive spirometry group using unpaired-t test of mean 1.50 ± 4.30; SD 1.08± 1.25; P value < 0.0001. In Graph-4, The pre and post test of Dyspnea-12 questionnaire in threshold inspiratory muscle training device group using paired-t test of mean 17.10 ± 13.80; SD 4.65±4.02; and P value is <0.0001. In Graph-5, The pre and post test of Dyspnea-12 questionnaire in Incentive spirometry group using paired-t test of mean 25.50 ± 23.20; SD 4.14± 3.94; P value is < 0.0001. In Graph- 6, The post values of Dyspnea-12 questionnaire in threshold inspiratory muscle training device and incentive spirometry group using unpaired-t test of mean 13.80 ± 23.20;SD 4.02±3.94; P value < 0.0001. These differences indicated that the threshold Inspiratory muscle training device was highly beneficial compared to the incentive spirometry device.

Discussion

This study examined the effects of a threshold Inspiratory muscle training device and incentive spirometry along with diaphragmatic breathing exercises on dyspnoea in third-trimester pregnant women. The interventions lasted for four weeks, and 62 antenatal women were divided into two groups: 31 of them underwent a threshold Inspiratory muscle training device along with diaphragmatic breathing exercises, and another 31 underwent an Incentive spirometry device along with diaphragmatic breathing exercises. The result of the study, evaluated by post-values of mean 13.80 ± 23.20;SD 4.02±3.94; P value < 0.0001. These values were considered to be extremely statistically significant. These differences indicated that the threshold Inspiratory muscle training device was highly beneficial compared to the Incentive spirometry device. Lee SY, Chien DK, et al., The study was to identify the mechanisms of change within the respiratory system during pregnancy. In this study, Dyspnoea in a normal pregnancy was reported to be distinguished from pathological dyspnoea.1 Amola M, Pawara S, Kalra S et al., stated that, The effect of threshold inspiratory muscle training device and diaphragmatic breathing exercises which reducing the symptoms of dyspnoea in third trimester antenatal women. 34 subjects were included in this study was performed by 4 weeks session and concluded inspiratory muscle training device are effectiveness on dyspnoea and pulmonary functions.3 Gamze Fisken et al., Has concluded that the effect of Abdominal breathing exercise is used in increasing blood sugar level of pregnant women which reduces depression and stress, 60 women were performed, around 30 days followed by less than eight weeks of intervention. The diaphragmatic breathing exercises which practice a session of 5 minutes is effectively significant.18

Conclusion

This study concluded that there was 20 % in prevalence of dyspnoea among third-trimester antenatal women and the effect of both threshold inspiratory muscle training device and incentive spirometry along with diaphragmatic breathing exercises which reduces the dyspnoea among third trimester antenatal women. But among the two interventions, the effect of threshold inspiratory muscle training device was found to be more significant than incentive spirometry in reducing dyspnoea among third trimester antenatal women.

Ethical Clearance: The research work has been approved by the ISRB Committee. Application No:03/084/2022/ISRB/SR/SCPT

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References


