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Original Article

Physiotherapy Section

Effect of Inspiratory Muscle Training and Diaphragmatic Breathing Exercises on Dyspnea, Pulmonary Functions, Fatigue and Functional Capacity in Pregnancy during Third Trimester

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ABSTRACT

Introduction: Pregnancy induces various physical and psychological alterations that cause dyspnea, reduced exercise capacity, fatigue, anxiety, altered pulmonary functions, nausea and vomiting. These alterations affect the maternal quality of life.

Aim: To compare the effect of Inspiratory Muscle Training and Diaphragmatic Breathing Exercises on dyspnea, pulmonary functions, fatigue and functional capacity in pregnancy during third trimester.

Materials and Methods: This experimental study was conducted on 34 subjects based on inclusion and exclusion criteria, which were randomly divided into Group A & B. Experimental group A received Inspiratory Muscle Training whereas group B performed Diaphragmatic Breathing Exercises for 4 weeks. The baseline measurement was taken on day one of the study. Dyspnea was assessed by Modified borg scale (MBS), Pulmonary functions (Expiratory Reserve Volume) were assessed by Spirometry, Fatigue was assessed by Multidimensional assessment of fatigue scale (MAFS) and Functional Capacity was assessed by 6 Minute Walk Test. All measurements were repeated at the end of 4th week. The baseline measurements at the end of 4th week were compared using the Independent t-test.

Results: Significant improvement in pulmonary function (ERV from mean value of 0.61 to 0.658) and functional capacity (6 MWT from mean value of 303.43 to 370.88) with decrease in dyspnea (MBS from mean value of 5.7 to 2.06) and fatigue score (from mean value of 31.1 to 22.29) were found in the group A that received the inspiratory muscle training as compared to group B that received diaphragmatic training. It is suggested that inspiratory muscle training improve the quality of life in pregnancy by reducing the work of breathing.

Conclusion: The Inspiratory muscle training was found to be effective and beneficial in relieving dyspnea, fatigue and improving pulmonary functions. Therefore, it can be used as a part of rehabilitation protocol in pregnancy.

Keywords: Breathlessness, Functional capacity, Lethargy, Pulmonary functions

INTRODUCTION

Pregnancy is a physiological phenomenon where in dyspnea, nausea, vomiting, fatigue and alterations in the pulmonary function are commonly seen affecting the maternal quality of life [1]. These changes are mediated by progesterone that increases respiratory oxygen consumption [2,3].

Studies suggest that pulmonary function in pregnancy is affected by earlier closure of small airways due to increase in oesophageal pressure, increase in respiratory drive and changes in thoracic cage dimensions [4,5]. There is a decrease in resting lung volumes because of the decrease in the downward movement of the diaphragm as the negative pressure becomes less negative [6]. There is a progressive decrease in expiratory reserve volume from 1300 mL to 100 mL and Residual volume from 1500 mL to 1200 mL which causes reduction in functional residual capacity by 17-21%. Tidal volume increases by 30-50% due to progesterone stimulus in the hypothalamus, which is the main cause of increased minute ventilation by 40% [7,8].

One of the most common problems that a woman, throughout the course of her pregnancy suffers from is dyspnea, which is estimated to be prevalent in approx 60-70% of healthy pregnant women. [9]. Previously, it was considered that this occurs because of an increased mechanical load associated with chest wall disfigurement caused by gravid uterus. In contrast, it has been found that dyspnea usually starts before any upward migration of diaphragm which concluded that there are some other associated factors which causes dyspnea in pregnancy [10].

Studies have shown that fatigue is another common problem affecting approximately 70% of pregnant women [11-13]. It has been suggested that the potential causes of fatigue during pregnancy are physical inactivity, rising levels of hormones and psychological and respiratory distress [14]. The level of fatigue increases throughout the period of pregnancy, however studies suggest that a pregnant woman experiences fatigue only during first and third trimesters and not in second trimester [15].

Several possible physiologic and psychological changes in pregnancy have been described that could affect fatigue levels, including increased oxygen consumption, foetal demands, cardiovascular, respiratory, urinary, and metabolic changes; and psychological stressors from adjustment to pregnancy and childbirth. An increased level of progesterone, known to cause drowsiness, may also contribute to fatigue [16].

Diaphragmatic breathing, or deep breathing, has been shown to be beneficial during pregnancy. It is done by taking deep inspiration through the nose which subsequently causes downward movement of diaphragm and expansion of abdomen outwards followed by slow exhalation through mouth which helps in decreasing respiration rate and maximising the exchange of blood gases [17]. Evangelodimou A et al., studied the effect of diaphragmatic breathing on dyspnea and exercise tolerance during exercise in COPD patients and concluded

that diaphragmatic breathing reduced the sensation of dyspnea and fatigue during exercise in COPD patients [18].

Inspiratory muscle training can be defined as series of resisted breathing exercises which helps to improve the capacity of respiratory muscle, makes breathing easier for the patients and thereby enhance exercise performance. Inspiratory muscle training has been used as an adjunct training with the routine pulmonary rehabilitation program in patients diagnosed or suspected with weakness of respiratory muscles [19].

There is a dearth of evidence that showed the effect of inspiratory muscle training during pregnancy in dyspnea, pulmonary functions, fatigue and functional capacity, but it has been proved in many studies that it improves respiratory strength and pulmonary lung functions in patients and healthy athletes [20-22]. Vasconcelos T et al., studied the influence of Inspiratory muscle training on lung function in female basketball players and concluded that a 4-week IMT protocol leads to a positive evaluation of basketball player's pulmonary function [23].

Thus, the purpose of this study was to assess the influence of Inspiratory muscle training on pregnant women and the reasons for selecting Inspiratory Muscle Training is that, it strengthens the weakened inspiration that predisposes the respiratory muscles to fatigue and helps reduces dyspnea and improve pulmonary functions.

MATERIALS AND METHODS

This experimental study was conducted in the SGT Hospital, from April 2018 to February 2019, Budhera, Gurugram. The sample size was calculated by G-Power software, using the power of study 0.95 and probability error 0.05. The calculated sample size was 34.

Women between the age group 20-30 years, primigravida and in their third trimester having moderate to severe dyspnea were included in the study. Subjects with the history of cardiovascular diseases, history of any lower limb injury that can affect 6 minute walk test, history of respiratory conditions that affect pulmonary functions like asthma, patients with thyroid problems and history of any psychological disease like anxiety or depression were excluded from the study.

The whole procedure was explained to the included subjects and the informed consent was taken from them prior to the study. A total of 34 pregnant women were randomly divided into two groups (A and B). The experimental group A (n=17) was given Inspiratory Muscle Training, and Control group B (n=17) performed Diaphragmatic Breathing Exercises. Exercises were performed for 4 weeks in both the groups.

Subjects in group A received the Inspiratory muscle training for 15 minutes, 5 days per week for 4 weeks. Each session lasted for 2 minutes and comprised of 7 sessions in it with the help of an Inspiratory training threshold device followed by 1 minutes of rest in-between the session. Training was started by instructing the subjects/women on the usage of the inspiratory pressure threshold device for Inspiratory Muscle Training. The training load used in this study was placed at a minimum of resistance for the first session and increased from day two of protocol, only allowing subjects to perform 30 breathing efforts. The training was performed in sitting position. Throughout the training session, subjects were asked to breathe through the mouthpiece against a pre-defined resistance set by the therapist [16].

Subjects in group B performed diaphragmatic breathing exercise for 15 minutes, 5 days for 4 weeks. The subjects/women were asked to sit comfortably and relax their body. Then they were instructed to breathe in (inhale) as deeply as they could through their nose while their abdomen expands with 5 seconds hold, keeping mouth closed and then breathe out (exhale) slowly as if they were going to whistle or gently flicker the flame of a candle while their abdomen contracted [24].

All the measurements were evaluated in sitting position. Subjects underwent baseline assessment for dyspnea (Modified Borg Scale which is a 10 points scale from 0 to 10; 0 indicates no difficulty in breathing at all and 10 indicates maximum breathing), pulmonary function (Spirometry according to the American Thoracic Society guidelines), fatigue (Multidimensional Assessment of Fatigue Scale which is a 16 item scale, measures fatigue in four dimensions: degree and severity, distress that it causes, timing of fatigue and impact of fatigue on different activities of daily living) and functional capacity (Six Minute Walk test by calculating the total distance walked in six minutes) [25-28]. All the measurements were repeated on the last day of fourth week.

STATISTICAL ANALYSIS

The data was analysed by using the software package SPSS 21 for window version. Mean and standard deviation of all the variables were calculated. The level of significance was set at $p<0.05$. Independent t-test was used to compare the pre and post-values in both the Groups.

RESULTS

This study was done on 34 subjects, 17 in each Group. At the beginning of the study on pre-exercise comparison, there was no significant difference ($p>0.05$) between the groups based on Age, BMI and outcomes measured MBS, 6 MWT, Fatigue, ERV [Table/Fig-1]. Within Group analysis of pre exercise and post exercise measurements showed more improvement in IMT Group as compared to diaphragmatic Group [Table/Fig-2,3]. After four weeks i.e., post intervention, between group comparison showed significant differences ($p<0.05$) in the outcomes measures MBS, 6 MWT, Fatigue and ERV concluding that significant improvement was found in the IMT Group (Group A) as compared to diaphragmatic Group (Group B) [Table/Fig-4].

Variables	Group A Mean±SD	Group B Mean±SD	p-value
Age (Years)	24.91±2.8	25.32±2.9	0.9^{NS}
BMI (Kg/m^2)	22.96±5.34	21.74±5.29	0.2^{NS}
ERV	0.614±0.5	0.606±0.6	1.3^{NS}
MBS	5.7±1.44	5.2±1.32	0.9^{NS}
6 MWT	303.43±43.4	315.45±40.2	0.9^{NS}
Fatigue	31.1±4.16	30.2±4.12	0.6^{NS}

[Table/Fig-1]: Baseline characteristics of the subjects of the study.
BMI: Body mass index, ERV: Expiratory reserve volume, MBS: Modified borg scale, 6 MWT: Six minute walk test; Unpaired t-test was used to calculate the p-value; NS: Non-significant; (Significance level: p≤0.05)

Variables	Pre-exercise (Mean±SD)	Post-exercise (Mean±SD)	p-value
ERV	0.614±0.5	0.658±0.067	0.013*
MBS	5.7±1.44	2.06±1.03	0.005*
6 MWT	303.43±43.4	370.88±43.10	0.021*
Fatigue	31.1±4.16	22.29±2.23	0.017*

[Table/Fig-2]: Comparisons of variables within group A at pre-exercise and post-exercise.
ERV: Expiratory reserve volume; MBS: Modified borg scale, 6 MWT: Six minute walk test; Paired-t-test was used to calculate the p-value; *- Significant (p ≤0.05)

Variables	Pre-exercise (Mean±SD)	Post-exercise (Mean±SD)	p-value
ERV	0.606±0.6	0.631±0.045	0.05*
MBS	5.2±1.32	3.12±1.58	0.01*
6 MWT	315.45±40.2	339.47±43.10	0.053*
Fatigue	30.2±4.12	25.44±5.64	0.069^{NS}

[Table/Fig-3]: Comparisons of variables within group B at pre-exercise and post-exercise.
ERV- Expiratory reserve volume, MBS: Modified borg scale, 6 MWT: Six minute walk test; Paired-t-test was used to calculate the p-value; *- Significant (p ≤0.05); NS: Non significant

Variables	Group A (Mean±SD)	Group B (Mean±SD)	p-value
ERV	0.658±0.067	0.631±0.045	0.046*
MBS	2.06±1.03	3.12±1.58	0.027*
6 MWT	370.88±43.10	339.47±43.59	0.043*
Fatigue	22.29±2.23	25.44±5.64	0.050*

[Table/Fig-4]: Comparison of variables between the Groups at Post-intervention. ERV: Expiratory reserve volume; MBS: Modified borg scale, 6MWT: Six minute walk test; Unpaired-t-test was used to calculate the p-value; *- Significant (p ≤0.05)

DISCUSSION

The present study intended to see the effects of Inspiratory muscle training and diaphragmatic breathing exercises on dyspnea, pulmonary functions, fatigue and functional capacity during third trimester in pregnancy. Pregnancy induced dyspnea is one of the most common problem, that occurs, as early as, in the first trimester. Studies have indicated physiological, mechanical and biochemical factors as causative factors for dyspnea during pregnancy [10, 29].

Gracia et al., in their study explained that the dyspnea during pregnancy can be caused due to hyperventilation for compensating reduced diffusion capacity. They suggested that it can be due to a decrease in alveolar PACO2 or the fact that pregnant woman are more aware of the increase in their ventilation [30]. P Weiner et al. reported a significant improvement in dyspnea during daily activities following the inspiratory muscle training protocol. It was reported that exertional dyspnea causes limitations during exercise performance and was suggested that the supervised inspiratory muscle training is beneficial in reducing dyspnea and increasing their submaximal exercise performance [31].

Maternal physiology is largely associated with marked alterations in the lung volumes and ventilation. Changes in the pulmonary functions begin in the second trimester of pregnancy. Various studies reported progressive decrease in expiratory reserve volume, increased inspiratory capacity and oxygen consumption during second trimester of pregnancy [32,33]. Also there is increased minute ventilation by 36% at eighth week of gestation and reaching 50% with the progressing weeks [34].

In the present study, there occur decreases in dyspnea by 63%, fatigue by 28.33% and increase in pulmonary function by 34%, functional capacity by 22.22% in the group who received inspiratory muscle training. Stephanie JE et al. defined Inspiratory Muscle Training as a sustained training method that works on the overload principle, and, has a positive effect on pulmonary functions, exercise performance, dyspnea and work capacity [35].

Fatigue is determined as one of the most neglected concern amongst the pregnant women. In a previous study, it has been reported that fatigue during pregnancy can lead to obstetrics risks, further predicting chances of caesarean delivery [36]. Studies have shown that women living sedentary lifestyle prior to pregnancy are more common to have lower exercise capacity than those who exercise regularly [37, 38]. The effect of Inspiratory Muscle Training have been proven in improving functional capacity in various conditions like COPD, hypertension, stroke and even in non-pathological cases wherein healthy individuals have adopted inspiratory muscle training in their exercise protocol [39].

The result of this study leads to believe that group who received Inspiratory muscle training showed significant improvement in reducing dyspnea grade, improving pulmonary function and helped reduce fatigue during third trimester in pregnancy as compared to the subjects who received Diaphragmatic breathing exercises training.

LIMITATION

Sample size of the study was small and follow-up was not done to assess the sustained effects of inspiratory muscle training.

Future recommendation of study: Effects of inspiratory muscle training on more physiological variables like pH, PaO_2, $PaCO_2$ and lactic acid can be studied on the pregnant women.

CONCLUSION

Inspiratory muscle shows positive effects in terms of reducing dyspnea, fatigue and improvement in pulmonary function and functional capacity in pregnancy during third trimester. And can be used as a part of rehabilitation protocol. Results of this study offer an exciting new opportunity to provide a non-pharmacological method to be included in the rehabilitation protocol for relieving symptoms.

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