Effect of diaphragmatic facilitation techniques on diaphragmatic excursion and maximum inspiratory pressure in obese population

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Abstract-
Background: Due to sedentary lifestyles and the use of high-calorie foods, obesity is fast increasing. When breathing normally, the diaphragm contracts, forcing the contents of the abdomen downward and forward. Because of the excess body fat that lines the chest and fills the abdomen in obese people, the normal function of the diaphragm is compromised. As a result, both MIP and MEP are reduced, which limits the action on the respiratory muscles. Distension of the diaphragmatic muscle also results in increased respiratory effort, which mechanically impairs the respiratory muscles. Obesity's mechanical effects on the diaphragm and chest wall result in diminished thoracic compliance and impaired diaphragmatic excursion. Methods for diaphragmatic facilitation caused abdominal muscles to relax and made diaphragmatic excursions easier. Method of scooping up; aid in diaphragm excursion. The recruitment of diaphragm muscles was enhanced by DCB. Techniques for stretching the diaphragm have an impact; they play a significant role in rib cage and abdominal excursion
Aim: To study the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and maximum inspiratory pressure in obese population.
Methodology: Participants were briefed about the nature of the study and the intervention. Their informed written consent was taken. 31 obese subjects of age group between 20-52 years old participated in this study. Both males and females included with BMI> 30. Systemic illness, abdominal or thoracic surgeries, dieting or exercise program, any addictions are excluded. Pre-intervention measures of the subjects for diaphragmatic excursion and MIP were taken prior to the treatment. Participant then received diaphragmatic facilitation techniques i.e, diaphragmatic breathing techniques, diaphragmatic scoop up techniques and diaphragmatic stretching techniques. The treatment was given for 3 days per weeks with 25-30 min. of overall duration for 1 session, for 3 consecutive weeks.
Outcome measures: Prior and after the treatment both the outcome measures, manual method of diaphragmatic excursion by using inch tape for diaphragmatic excursion and digital manometer for MIP were measured.
Results: Statistical analysis was done using Wilcoxon test. The statistical analysis of pre and post intervention data shows there is significant effect on diaphragmatic excursion and MIP in all obese subjects.
Conclusion: The study was done on obese subjects to identify the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and MIP. This state that diaphragmatic facilitation techniques are effective on diaphragmatic excursion (Also according to BMI classification) and MIP was proven to significant p values. Hence, diaphragmatic facilitation techniques are very effective and simple to apply in diaphragmatic excursion and MIP in obese population. According to BMI classification, result of the present study demonstrated that diaphragmatic excursion is statistically significant but the MIP didn't show any statistically significant effect in BMI classification

***Key words*: MIP, CDB, DFT, DE, DM.**

INTRODUCTION

According to the World Health Organization, obesity is frequently described as a condition of abnormal or excessive fat buildup in adipose tissue, to the point that health may be harmed.[8] The body mass index (BMI) is a popular method of measuring obesity in a population. Obesity is typically defined as having a BMI of 30 kg/2 or higher.[13]

In India, the prevalence of obesity is found to be 33% in males and 44.7% in women. Females are observed to be more likely than males to be obese. among adults between the ages of 20 and 40. age is about 72.9%. Adipose tissue, which is made up of the lipid-storing cells called adipocytes, is what causes obesity, which is a state of abnormal or excessive fat.[12] These adipocytes exude chemicals that control endocrine function. These molecules include the hormone leptin, which regulates energy levels, the cytokines TNF alpha and IL6, the insulin sensitivity-regulating molecules adiponectin, restin, and RPB4, the prothrombotic factor plasminogenic activator inhibitor, and the molecules that control blood pressure. Increased adipose tissue results from adipose cell expansion brought on by excessive intracellular lipid accumulation as well as from an increase in the number of adipocytes.

Due to sedentary lifestyles and the use of high-calorie foods, the prevalence of obesity has been steadily increasing from 1998 to 2018. Medical conditions including PCOS and asthma, as well as age-related drugs and genetics, as well as social variables like addiction to alcohol and tobacco, are major contributors to obesity.[14]

The diaphragm is a vital respiratory muscle. The "fibromascular sheet," which is dome-shaped and serves as both the thorax's floor and the abdomen's roof, divides the thorax from the abdomen. When breathing normally, the diaphragm contracts, forcing the contents of the stomach down and forward simultaneously, and the external intercostal muscles contract, pulling the ribs up and forward The diaphragm is mechanically compressed as a result of obesity. Because of the additional body fat that lines the chest and fills the belly in obese people, the diaphragm's natural function is compromised. This inhibits the action of the diaphragm muscle.[5]

Multiple factors make obesity detrimental to ventilator function. All lung capacities normally decreases as BMI increases but expiratory airflow stays normal. Obesitys mechanical effects on diaphragm and chest wall result in diminished thoracic compliance and impaired diaphragmatic excursion.

Due to the restricted rib and diaphragmatic mobility caused by these structural changes in the thoracic and abdominal regions, the respiratory system's dynamics are altered and its compliance is decreased, which results in mechanical impairment of the respiratory muscle. The main respiratory muscle, the diaphragm, contributes up to 70% of resting ventilation.[5]

The mass loading of the ventilatory system brought on by obesity, particularly on the abdominal component of the chest wall, increases the static pressure in the respiratory system and causes direct mechanical changes due to fat depositions on the chest wall, abdomen, and upper airway as well as systemic inflammation equilibrium in the respiratory system.[5] When there is severe obesity, the lung function exhibits constrictive patterns with a decrease in lung volume that accounts for 20 to 30% of the total lung capacity and vital capacity. Obesity suggests that the respiratory muscles are under a severe stress, which could cause respiratory complication.

Higher pulmonary blood volume, the closure of dependent airways with the development of tiny patches of atelectasis, or higher alveolar surface tension as a result of a decline in FRC can all contribute to a drop in lung compliance. Obese people have less compliance in their chest walls. (and was especially reduced in the supine position).5

Additionally, modifications in pulmonary function parameters are influenced by modifications in the neurological control of breathing and increases in thoracic blood volume brought on by chest fat accumulation. Compared to healthy persons, patients with morbid obesity (BMI 40 kg/m2) had faster respiratory rates. In four investigations, obese participants' mean respiratory rates ranged from 15.3 to 21 breaths per minute, compared to 10 to 12 breaths per minute for normal subjects. Reduced respiratory reserve volume is an effect of obesity on lung volume. Increased thoracic or mediastinal fat in obese individuals has an additional impact on lung volume.

Maximal inspiratory pressure (MIP) and Maximal expiratory pressure (MEP) measurements can be used to determine the strength of the respiratory muscles.6 Due to diaphragmatic muscular distension in obese individuals, which results in greater respiratory effort, both MIP and MEP are decreased. MIP measures the strength of the inspiratory muscles, which is related to diaphragmatic strength. The muscles in the intercostals and abdomen produce MEP.5

MIP and MEP measurement are able to detect diaphragmatic weakness and assess respiratory muscle weakness. Measurement of respiratory muscle strength is used in clinical practise to identify, diagnose, and treat respiratory weakness. Maximal inspiratory pressure, or MIP, is most frequently measured.9

Right now, using a digital pressure manometer is advised. it is accurate to within 0.2%.The patient is instructed to execute maximum inspiration through a mouthpiece on a digital manometer to which a tube is linked.4

Diaphragmatic controlled breathing is a type of breathing exercise that strengthens the diaphragm15 and has many advantages, including increasing diaphragm excursion (ascent or desceny), decreasing work of breathing, and improving gas exchange or oxygenation. It promotes relaxation and lessens the damaging effects of the stress hormone cortisol on the body.11

Enhances core muscle stability, lowers heart rate, and lowers blood pressure. It also increases the body's capacity to withstand strenuous exercise. The semi-fowlers position is intended to facilitate diaphragmatic excursions and improve the area of the diaphragm. This position also induces abdominal muscle relaxation. Method of scooping up; encourage diaphragm excursions.1 Diaphragm muscle activation and respiratory muscle control were both improved by DCB during breathing exercises.

Effect of diaphragmatic stretching techniques; these techniques work by relaxing the diaphragm in its resting condition and enhancing its ability to contract and relax, which increases the pressure gradient between the thorax and abdomen.2 Stretching results in an activation of the muscle spindle, which boosts sensory afferent stimulation, boosts neuromotor response, and ultimately increases muscular tension and viscoelasticity while reducing muscle stiffness. Take into consideration the diaphragm's intricate structure and crucial contribution to subject rib cage and abdominal excursions.3

1) MATERIALS AND METHODOLOGY

MATERIALS:

1] FOR MANUAL METHOD:

1. Data collection form/ assessment form
2. Pen
3. Paper
4. Chair without armrest
5. Plinth
6. Measuring Tape

2] FOR DIGITAL MANOMETER:

A handheld digital manometer commonly is used to measure pressure

METHODOLOGY:

1. Type of study: Experimental study
2. Type of sampling: Simple random sampling
3. Study design: Randomized clinical trial

4. Sample size: 31
5. Study duration: 6 months
6. Study setting: Sangli community

OUTCOME MEASURES

1. Body Mass Index: WHO criteria for screening obesity for Asian population.

BODY MASS INDEX KG/M^2	**Interpretation**
<18.5 KG/M^2	Underweight
18.5-22.9 KG/M	Normal
23.0-24.9 KG/M	Overweight
25.0-29.9 KG/M	Obesity I
>30.0 kg/m	Obesity II

2. TAPE METHOD OF ASSESSMENT OF DIAPHRAGMATIC EXCURSION:

- Assessment of diaphragmatic movement can be made with mediated percussion
- To assess diaphragmatic excursion, the patient must be seated and wearing minimal clothing. While the patient is breathing calmly, the patient's lungs are pounded from the top to the bottom, and on the left and right sides, lines are drawn to mark the transition from resonance to dullness.
- The patient is instructed to inhale deeply and hold the breath once the therapist has drawn these lines. The therapist now draws a second line and continues pounding from the first line downward to pinpoint the new point of dullness to resonance.
- A tape measure was used to measure the distance between these two sites, known as the diaphragmatic excursion. Typically, it is 3 to 5 cm.[10]

3. RESPIRATORY PRESSURE METER:

- DIGITAL MANOMETER: This device measures maximum inspiratory pressure to test the strength of the respiratory muscles.
- The subjects are instructed to sit down. After that, participants are instructed to firmly seal their lips around the mouthpiece. The MIP value will be derived from the remaining
- volume. The highest value will be taken after at least three repetitions with a one-minute pause in between.

1] Diaphragmatic Breathing Technique :

- The subject is positioned in a semi-fowlers position with their knees bent and their pelvis tilted back, which causes their abdominal muscles to relax and facilitates diaphragmatic excursion. The patient is asked to express satisfaction by placing their hands on the therapist's abdomen. The participant is instructed to inhale through their nose and then slowly exhale.
- Start by observing the subject's breathing rhythm. Following the subject's abdominal motions without interfering with his or her breathing rhythm, a proper workout demonstration was given. The umbilicus on the subject's abdomen was the location of the therapist's hand. ask the subject to take two or three breaths.
- Following instruction to inhale through the nose and elevate the abdomen against the hand

2] Diaphragmatic breathing scoop techniques:

- This treatment involves placing the client in a semi-fowlers or side lying posture, bending the knees, and relaxing the abdominal muscles.
- Start by observing the subject's breathing rhythm. Following the subject's abdominal motions without interfering with his or her breathing rhythm, a proper workout demonstration was given. The umbilicus on the subject's abdomen was the location of the therapist's hand. ask the subject to take two or three breaths.
- Scoop stretch involves inhaling while pushing against the therapist's hand.
- After The individual was told to breathe in through their nose and lift their abdomen up against a hand. After the exhale rate returned to normal, the hand was scooped up beneath the anterior thorax and a gradual inward stretch was applied. Each breath was taken using the same process.

3] Diaphragmatic stretching technique:

- The participant was seated straight. The therapist placed his or her hand around the thoracic cage with fingers under the costal margin while standing behind the victim..
- The participant relaxed the rectus abdominal muscles by slightly rounding the trunk. The therapist relaxed the hand caudally and grabbed the lower rib and costal borders when the individual breathed. Five to ten minutes were spent stretching.[7]

RESULTS

Statistical analysis was done using Wilcoxon and ANOVA test.

Table No.1: Analysis according to Gender

Gender	Frequency	Percent
Male	13	42
Female	18	58
Total	31	100

Graph No.1: Analysis according to Gender

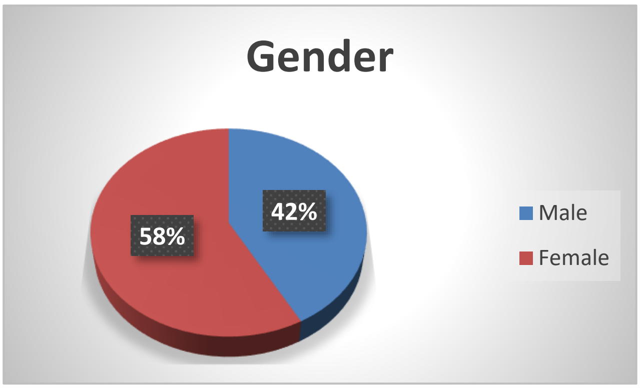


Table No.2: Descriptive analysis of Age and BMI `
Descriptive Statistics

Particular	Minimum	Maximum	Mean	SD
Age	19.00	52.00	37.71	11.55
BMI	29.40	48.20	37.44	4.23

Graph No.2: Descriptive analysis of Age and BMI

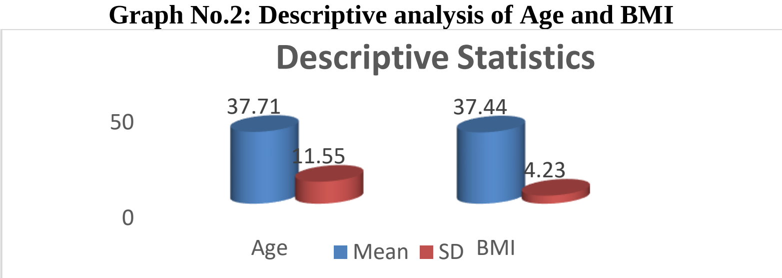


Table No.3: Analysis of Within group Pre and post test of Diaphragmatic Excursion
Comparison of pre-test and post-test Diaphragmatic Excursion scores by Wilcoxon test

Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	Z-value	p-value
Pre-test	2.72	0.76	0.31	0.13	2.44	4.893	0.001*
Post-test	3.03	0.85					

Graph No.3: Analysis of comparison of pre-test and post-test Diaphragmatic Excursion

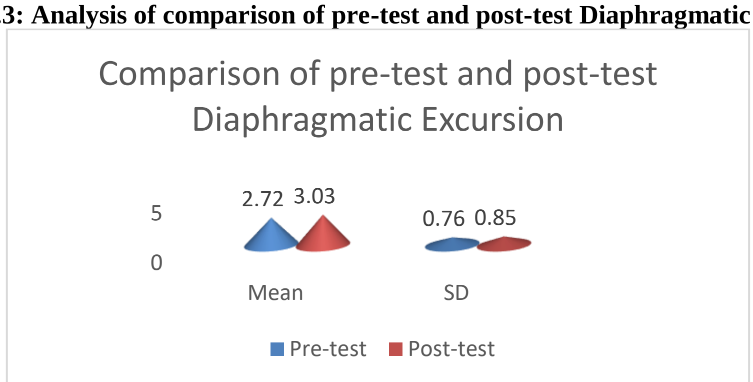


Table No.4: Comparison of pre-test and post-test MIP scores by Wilcoxon test

Times	Mean	SD	Mean Diff.	SD Diff.	Effect size	Z-value	p-value
Pre-test	83.90	18.17	6.42	9.28	0.69	4.712	0.001*
Post-test	90.32	19.18					

Graph No.4: Analysis of comparison of pre-test and post-test MIP

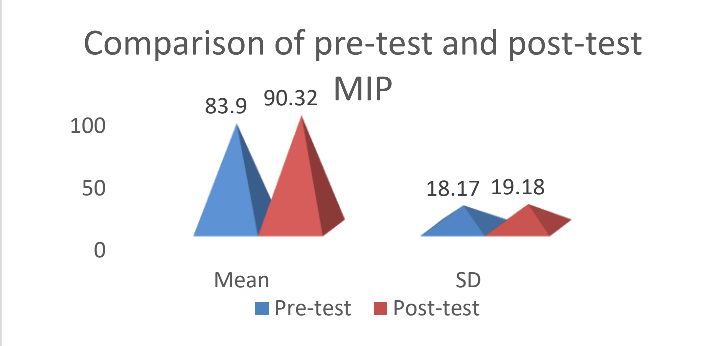


Table No.5: ANOVA test for Diaphragmatic Excursion Pre Values

BMI Grade	Mean	SD	Mini	Max	f-value	p-value
Obesity class 1	3.66	0.48	3.00	4.00	33.813	0.001*
Obesity class 2	2.62	0.38	2.20	3.70		
Obesity class 3	1.87	0.13	1.70	2.00		
Total	2.71	0.76	1.70	4.50		

Above table indicates BMI grade wise variations in the mentioned categories and there is a statistical reliable difference among the above categories as the p-value is less than 5% [0.001 < 0.05]

Graph NO.5: ANOVA test for Diaphragmatic Excursion Pre Values and BMI grade

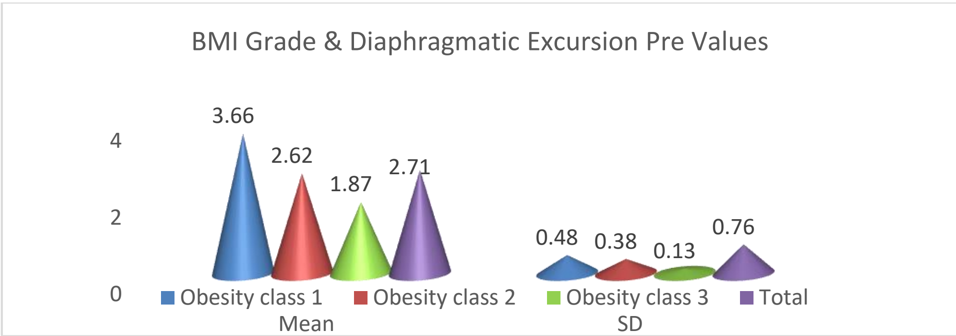


Table No.6:ANOVA test for Diaphragmatic Excursion Post Values

BMI Grade	Mean	SD	Mini	Max	f-value	p-value
Obesity class 1	4.08	0.54	3.40	4.50	34.111	0.001*
Obesity class 2	2.94	0.41	2.40	4.00		
Obesity class 3	2.07	0.23	1.80	2.40		
Total	3.03	0.85	1.80	5.00		

Above table indicates BMI grade wise variations in the mentioned categories and there is a statistical reliable difference among the above categories as the p-value is less than 5% [0.001 < 0.05]

Graph No.6: ANOVA test for Diaphragmatic Excursion Post Values and BMI grade

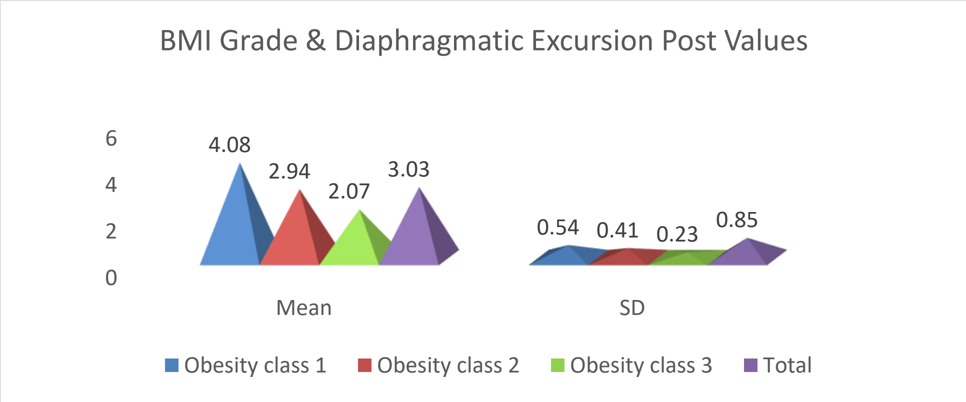


Table No.7: ANOVA test for MIP Pre Values

BMI Grade	Mean	SD	Mini	Max	f-value	p-value
Obesity class 1	80.33	13.29	72.00	107.00	1.048	0.387
Obesity class 2	81.94	18.17	64.00	115.00		
Obesity class 3	87.71	21.23	60.00	107.00		
Total	83.90	18.17	60.00	115.00		

Above table indicates BMI grade wise variations in the mentioned categories and there is no statistical reliable difference among the above categories as the p-value is more than 5% [0.001 < 0.387]

Graph No. 7: ANOVA test for MIP Pre Values and BMI grade

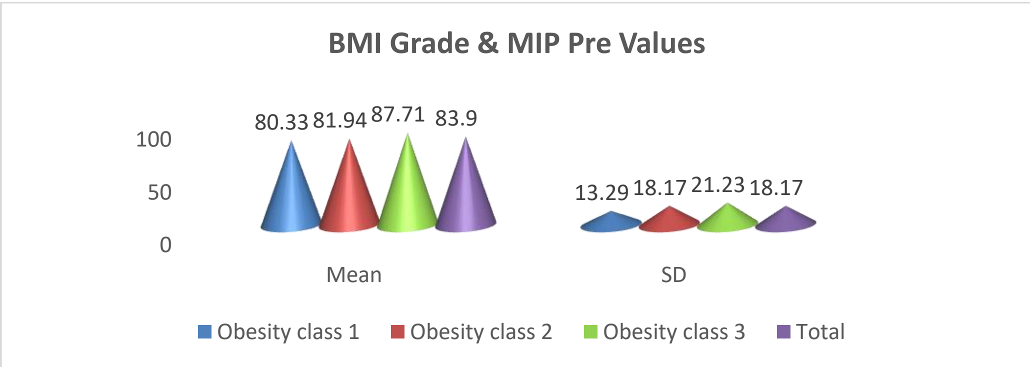
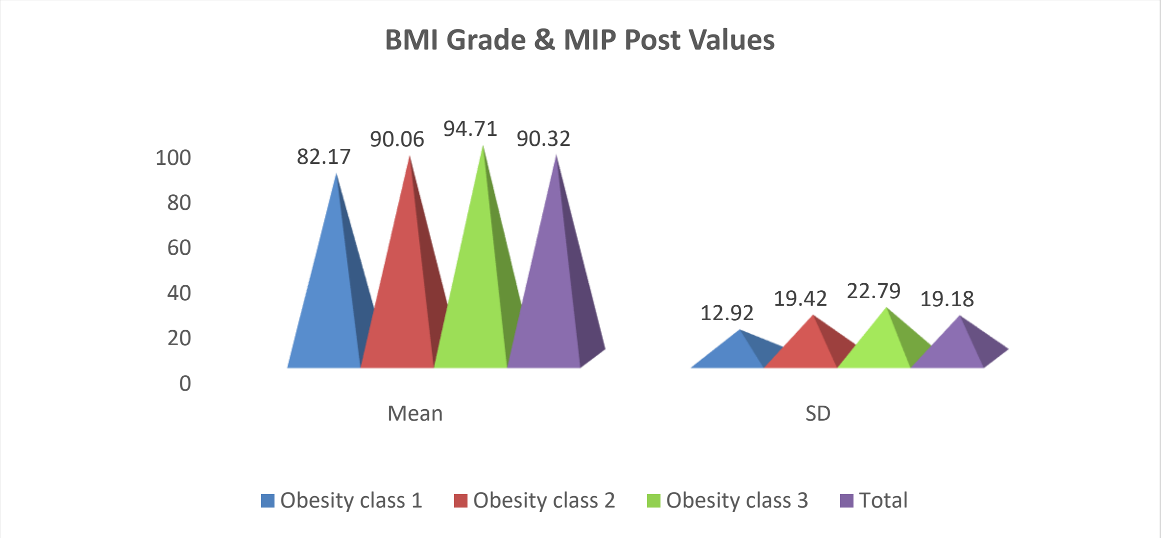


Table No.8: ANOVA test for MIP Post Values

BMI Grade	Mean	SD	Mini	Max	f-value	p-value
Obesity class 1	82.17	12.92	73.00	108.00	0.946	0.432
Obesity class 2	90.06	19.42	67.00	120.00		
Obesity class 3	94.71	22.79	62.00	116.00		
Total	90.32	19.18	62.00	120.00		

Above table indicates BMI grade wise variations in the mentioned categories and there is no statistical reliable difference among the above categories as the p-value is more than 5% [0.001 < 0.432]

Graph No.8: ANOVA test for MIP Pre Values and BMI grade



Results from analysis:

The final analysis proves that both the groups were clinically significant in case of both Diaphragmatic excursion and MIP. Although in case of MIP, analysis proves that there is statistically significance in MIP but according to grades of BMI there is no statistical reliable difference among the p – values.

Wilcoxon test was used to analyse the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and MIP in obese population which showed that there was significant increase in Diaphragmatic excursion score [p=0.051] and MIP score [p=0.001].

ANOVA test was again used to analyse the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and MIP in obese population according to BMI grades which showed that there was significant difference in diaphragmatic excursion; between grade 3 than grade 1 and grade 2, Also ANOVA test was again used to analyse for MIP showed that there was no statistically significant difference in MIP according to BMI grades.

However the The comparison of pre-test and post-test of Diaphragmatic Excursion MIP mean value indicated changes in post treatment and higher values are recorded for post treatment outcome and also standard deviation shows the limited consistency with post treatment value which is more than pre values. Based on the results of test analysis at 5% significance level, there is a significant statistical reliable difference between the pre and post treatment values with p-value of diaphragmatic excursion is 0.051 and MIP is 0.001 is less than 5% significance level [i.e. 0.001 <0.05] in the study and therefore it justifies the improvement in health outcome post intervention.

By using ANOVA test for pre-test and post-test of diaphragmatic excursion according to BMI classification there is an variations and statistical reliable difference among the obesity class as the p-value is less than 5%[0.001 <0.05]. According to BMI grades class 3 obesity showed greater significant difference in pre and post values because of less subjects included in this BMI grade. class 1 obesity having greater effect than class 2 obesity have lowest difference in pre and post values.

DISCUSSION:

The present study an experimental study was conducted to see the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and maximum inspiratory pressure in obese population .This study was aimed to find out the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and maximum inspiratory pressure in obese population. All individuals were evaluated using body mass index [BMI] as per WHO guidelines. The present study shows statistically significant result in obese subjects.

One of the factors that influences diaphragmatic excursion is obesity; the diaphragm is mechanically compressed. Since the diaphragm is the primary respiratory muscle and accounts for up to 70% of resting ventilation, so MIP is progressively decreases. The use of diaphragmatic facilitation techniques has been shown to have positive effects on the recruitment of the diaphragm muscles in stable COPD patients, according to a number of scientific studies that support its effectiveness. Better respiratory muscle control as a result of improved breathing retraining led to an increase in MIP.

A Diaphragmatic breathing exercise that helps to strengthen the diaphragm muscle is called diaphragmatic breathing. The major muscle of inspiration, the diaphragm contracts during inspiration to increase intra-thoracic pressure, which improves thoracic, lung function, and breath-hold capacity..

The diaphragmatic stretch technique aims to increase the diaphragm's capacity for both active contraction and passive relaxation. As a result, there is a difference in pressure between the thorax and abdomen. Receptors are triggered in the region of the muscle and tendon. The golgi tendon organ, in particular, has an inhibitory function that increases viscoelasticity and muscular tension, which in turn lessens muscle stiffness and enhances thoracic mobility.

This can be postulated because statistically significant within-post test value differences were discovered in diaphragmatic facilitation techniques. The Aishwarya Nair et al., concluded that the diaphragmatic stretch technique can be safely recommended with clinically stable COPD patient to improve diaphragmatic excursion.

Visceral content was pushed under the diaphragm using CDB and scoop technique, which enhanced the diaphragm's oppositional component. The diaphragm muscle was more actively recruited. Additionally, breathing exercises have improved po2 and pco2 and have had a stronger impact. Better respiratory muscle control is achieved by breathing exercises, which also lessens the tiredness of the accessory muscles and enhances their functionality.
According to Sudeep Kale et al.,performed CDB and scoop techniques with a semi-fowlers position, flexed knees, and a relative posterior pelvic tilt induced abdominal muscle relaxation and facilitated diaphragmatic excursion.
By monitoring the maximal inspiratory pressure, a digital manometer can evaluate the strength of the inspiratory muscle.technique is used to test respiratory muscle weakness in patients, and because it provides accurate results, it has also been employed on healthy persons.
According to Rodrigo Torres-Castro, healthy adults' MIP can be measured with a non-clinical digital manometer.It is necessary to conduct safety profiling among human participants and additional validation at lower pressure.
According to our study the mean baseline value for diaphragmatic excursion before intervention is 2.72 and after intervention is 3.03 and for MIP before intervention is 83.90 and after intervention is 90.32. The comparison of pre-test and post-test of Diaphragmatic Excursion MIP mean value indicated changes in post treatment and higher values are recorded for post treatment outcome and also standard deviation shows the limited consistency with post treatment value which is more than pre values.
Based on the results of test analysis at 5% significance level, there is a significant statistical reliable difference between the pre and post treatment values with p-value of diaphragmatic excursion is 0.051 and MIP is 0.001 is less than 5% significance level [i.e. 0.001 <0.05] in the study and therefore it justifies the improvement in health outcome post intervention.
By using ANOVA test for pre-test and post-test of diaphragmatic excursion according to BMI classification there is an variations and statistical reliable difference among the obesity class as the p-value is less than 5%[0.001 <0.05]. According to BMI grades class 3 obesity showedgreater significant difference in pre and post values because of less subjects included in this BMI grade. class 1 obesity having greater effect, but in class 2 obesity having lowest difference in pre and post values.
According to BMI classification pre-test and post-test of MIP there is no statistical reliable difference among the obesity categories as the p-value is more than 5% [0.001< 0.387].
In our study we found that there was a statistically significant difference in the diaphragmatic excursion and MIP following intervention within obese individuals. In present study there is 13 males and 18 females are included.
The subjects were given diaphragmatic facilitation techniqiesare given6 days a week, for 20-25 minutes/day, for 3 consecutive weeks. The stretching was performed for 5- 10 minutes.
This is the first study to find out the diaphragmatic facilitation techniques on are diaphragmatic excursion and MIP in short duration of 3 weeks. A total 37 subjects were included in the study were screened according to selection criteria. Were 4 subjects not meeting the inclusion criteria and 2 dropouts from intervention. The pre and post test values measured in the study are diaphragmatic excursion and MIP.

CONCLUSION:
The study was done on `obese subjects to identify the effect of diaphragmatic facilitation techniques on diaphragmatic excursion and maximum inspiratory pressure [MIP]; this state that diaphragmatic facilitation techniques are effective on diaphragmatic excursion {according to BMI classification} and MIP was proven to significant p values. Hence, diaphragmatic facilitation techniques is very effective and simple to apply in diaphragmatic excursion and MIP in obese population.
According to BMI classification; class 3 obesity showed greater significant difference in pre and post values because of less subjects included in this BMI grade. class 1 obesity having grater effect than class 2 obesity have lowest difference in pre and post values.

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