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Effect of positive expiratory pressure (PEP) on VO2 max, SPO2, PR of obese class I individuals

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Abstract
This study aimed to find out the Effect of PEP breathing on VO2max, SPO2, PR in obese class I individual at Higher educational institutions in Miraj. 40 individuals participated in the study. The VO2max, SPO2 and PR was taken as an outcome measure post Queens's college step test for assessing the effect of PEP breathing. All the participants were assessed for inclusion and exclusion criteria first. 36 out of 40 participants were included in the study. These 36 participants were further randomly divided into 2 groups of 18 each ie. For PEP breathing and habitual breathing, after 4days the groups were crossed and step test was done again. VO2max, SPO2, PR were measured post-test. PEP breathing was found to be effective. t test was done to compare the observed results of increase in VO2max, SPO2 and decrease in PR. With a P-value of 0.005, 0.002, 0.001* respectively, it revealed that PEP breathing is statistically effective in obese class I individuals.

Keywords: Obesity, PEP breathing, VO_{2max}, Queens's college step test

1. Introduction
Obesity is an emerging health problem throughout the world. Obesity and overweight have become a global epidemic. Altered food habits and modern lifestyle have added to this epidemic. Urban Indian adults nearly 30-65% are obese or overweight.
Lately, cardiovascular disease is raising in the adult generation. Decrease of cardiovascular fitness and increase in cardiovascular risk profiles are seen in the young generation, which has led to increased cardiovascular comorbidities later in middle age. The effects of obesity on the respiratory system have been increasingly studied. The accumulation of fat in the body causes changes in respiratory physiology, with consequent impairment of various lung function parameters. Different patterns of body fat distribution differentially and negatively affect the function of the respiratory system [1].
Jones and Nzekwu reported that decreases in ERV, FRC, and TLC seem to exhibit an exponential correlation with elevated BMI and are directly correlated with the mechanical effects caused by fat accumulation in the chest and abdomen.
In accordance with these authors, accumulation of fat in the thoracic-abdominal region is one of the main causes of the observed decrease in ERV. It is worthy to note that marked decrease in ERV may lead to abnormalities in ventilation distribution, with closure of airways in the dependent zones of the lung and inequalities in the ventilation-perfusion ratio [2].
Many studies have shown a strong relation between low cardio respiratory fitness and mortality. Peak oxygen uptake (VO2 max) measurement is one of the best ways to asses cardiorespiratory fitness. It is an important functional capacity for the supply and transportation of energy and oxygen [1]. Peak oxygen uptake is the major indicator of aerobic capacity, cardiovascular fitness, and endurance Performance. The maximal exercise test on a cycle ergo meter or treadmill in which vo2 measured directly is the gold standard measurement for aerobic fitness test. Even if it is the gold standard method it is impractical in non-laboratory and field-test situation, as the equipment's and materials are expensive and also require expert level of technical supervision. And for the patients who are not advised to do exhaustive exercise, this method is unsuitable. And for this reason, many other tests have been made for the measurement of aerobic fitness. Some these tests are field tests requiring maximum effort, for example the 20-m multiple shuttle run, whilst others are submaximal treadmill, cycle ergo

meter or bench-stepping tests with single stage or multistage protocols. The basic premise of submaximal testing is that linear relationship exists between heart rate and oxygen consumption.

Step tests are one of the most widely used field tests for estimating VO2Max. Stepping requires no elaborate or expensive equipment, no calibration, and can be easily administered to large numbers of people. Most commonly administered step tests are performed at a fixed cadence on a bench of a fixed height. One such test is the Queens College step test (QCT) developed by Mc Ardle et al, and Manouri Shamsi et al. [3]

Studies have shown that there is an increase in cardiorespiratory fitness by the use of PEP device during 6 minute walk test in COPD patients [4, 5].

Positive expiratory pressure has many beneficial effects, studies have shown that it increases alveolar ventilation (resulting in pulmonary expansion) [5], lung volume, gas exchange and decreased atelectasis.

2. Material and Methodology

2.1 Materials

- PEP mask of 5cm H2O resistance (Brand: KOO EUROPE)
- Weighing scale
- A stadiometer.
- Pulse oximeter.
- Stopwatch.
- Metronome. [Cadence regulated by metronome set at 96 bpm for 24cycles/min]
- 41.3 cm step.
- Pen
- Paper

2.2 Methodology

2.2.1 Participants

Subjects who completed the inclusion and exclusion criteria were included in the study. The inclusion criteria, both males and females between the age group of 19 - 30 years, obese class I individuals (BMI - 25-30 using Asia Pacific categorisation) having sedentary lifestyle. The exclusion criteria were Cardiorespiratory, neurologic, metabolic and musculoskeletal disorders, Smoker or any other addictions affecting health. Written informed consent was obtained from the participant.

2.2.2 Procedure

Positive expiratory pressure was applied by a PEP mask of 5cm H2O resistance. This device has various orifice resistor inducing a flow-dependent expiratory pressure in the range of 05 –20 cm H2O. It also includes a one-way valve that opens upon inspiration. In all subjects, expiratory resistance of the PEP device was set to the largest available aperture (5.0 mm). The device was placed on the subject's Face and held in place with a strap. And wearing this device/ mask subjects are instructed to perform queens college step test (PEP allocated group). Post-test PR and Spo2 is taken by Pulse oximeter, and Vo2max was calculated.

The step test was performed on a stool of 16.25 inches (41.3 cm) height for a total duration of 3 minutes at the rate of 24 cycles per minute for males and 22 cycles per minute for females which was set by a metronome. After completion of the exercise, the subject was asked to remain standing and pulse rate was measured from 5–20 seconds of the recovery period. And the following equation was used to predict the maximum oxygen uptake capacity

PVO2max (ml/kg/min) = 111.332(0.426pulse rate in beats/min) for males

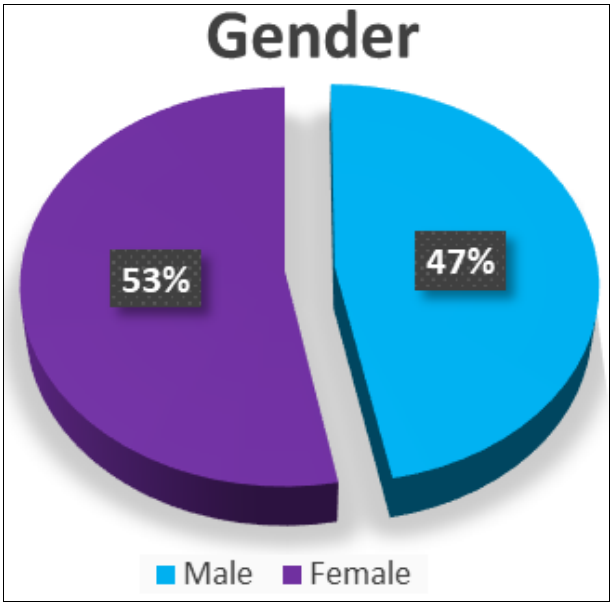
VO2max= 65.81-(0.1847*HR) for females

The participants was made fully familiar with exercise testing procedures. They were instructed to arrive in a rested and fully hydrated state, at least 3-h postprandial and to avoid strenuous exercise in the 48-h preceding the test session.

3. Results

Table 1: Shows frequency and percentage of gender

Gender	Frequency	Percent
Male	17	47
Female	19	53
Total	36	100.0

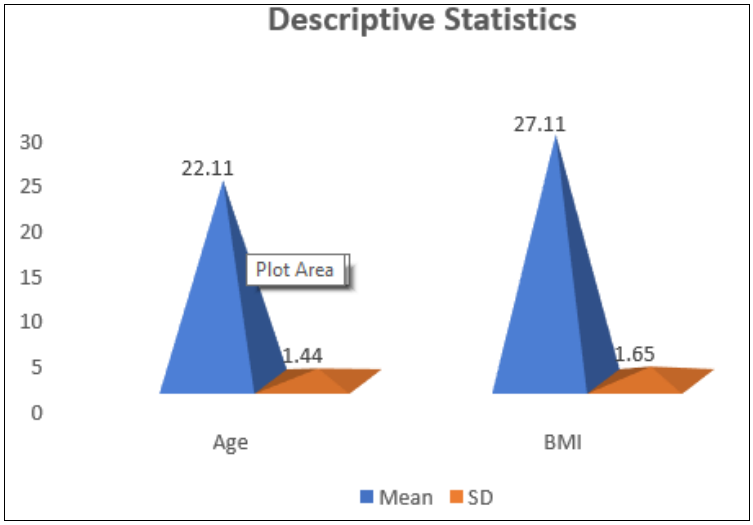


Graph 1: Shows percentage of males and females in the study

3.1 Descriptive Statistics

Table 2: Shows Peak values, Mean and SD of Age and BMI

Particular	Minimum	Maximum	Mean	SD
Age	20.00	25.00	22.11	1.44
BMI	25.00	30.00	27.11	1.65



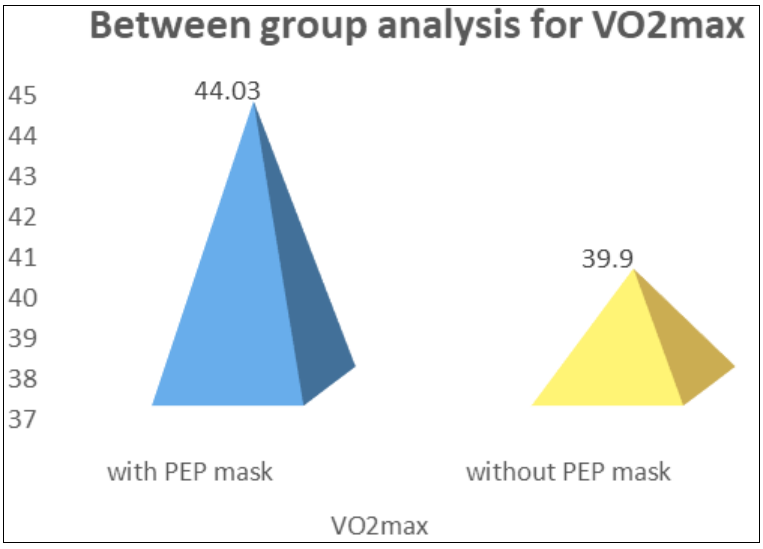
Graph 2: Shows Mean and SD of Age and BMI

3.2 Between group analysis for VO2max

Table 3: Mean and SD of VO2max of both groups

Variable	Group	Mean	SD	t-value	p-value
VO2max	with PEP mask	44.03	6.73	2.926	0.005*
	without PEP mask	39.90	5.14		

From the above table it is observed that between groups analysis is significant for VO2max at 5% level significance. There is a statistical significant difference between the groups. Since VO2max values are higher for with PEP mask as compared to without PEP mask.



Graph 3: Mean of VO2max of both groups

3.3 Between group analysis

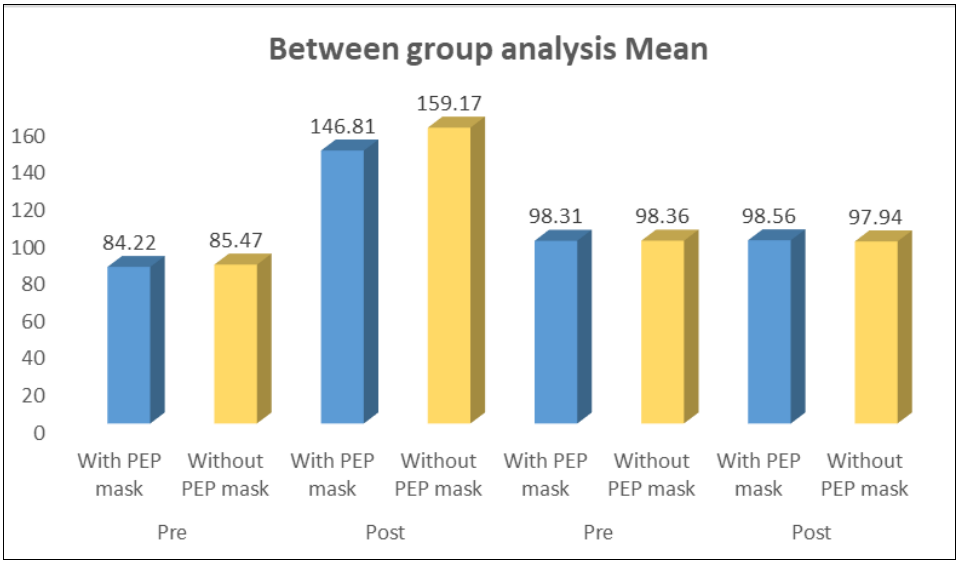
Table 4: Mean and SD of PR and SPO2 of both groups

Variable	Time frame	Group	Mean	SD	t-value	p-value
PR	Pre	With PEP mask	84.22	12.36	0.412	0.681
		Without PEP mask	85.47	13.31		
	Post	With PEP mask	146.81	13.99	3.915	0.001*
		Without PEP mask	159.17	12.77		
SPO2	Pre	With PEP mask	98.31	0.75	0.289	0.774
		Without PEP mask	98.36	0.72		
	Post	With PEP mask	98.56	0.69	3.303	0.002*
		Without PEP mask	97.94	0.89		

From the above table it is observed that between groups analysis is significant for PR & SPO2 post time interval at 5% level significance with statistical significant difference between the groups across the post time intervals. Pre values have indicated non-significant outcomes and there is no statistical significant difference between the groups across the time intervals.

Since PR post value is low for with PEP mask group as compared to without PEP mask group.

Since SPO2 post value is high for with PEP mask group as compared to without PEP mask group.



Graph 4: Mean of PR and SPO2 of both groups

4. Discussion

1. This study aims to evaluate the effectiveness of Positive Expiratory Pressure (PEP) on VO2max, SPO2 and Pulse Rate (PR) in subjects of obese class I. A total of 40 subjects were taken for screening out of which 36 subjects were recruited in the study based upon inclusion and exclusion criteria. Further, these 36 subjects were randomly allocated to group A (PEP breathing) and B (habitual breathing) each group was having 18 subjects, after Queens College step test a wash out period of 4days was given then the group was crossed over ie. Group A with habitual breathing and vice versa.
2. Group with PEP breathing were applied PEP with a PEP mask of 5cm H2O resistance and was made to do queens college step test wearing the mask. While the group with habitual breathing underwent the conventional method of step test.
3. The group with PEP showed clinically and statistically significant effect on VO2max, SPO2 and PR in Queens College step test.
4. During PEP breathing, the breathing rhythm is altered. By increasing both inspiratory and expiratory muscle activity, PEP has been demonstrated to increase VT and decrease respiratory frequency. One explanation for why FRC rises is the shift in breathing pattern, which results in a reduced exhaled volume due to decreased expiratory flow and higher expiratory duration. Improved gas exchange is achieved by breathing for a long time with a normalised lung capacity.
5. An alternate explanation for an increase in lung capacity is that, it is a physiological response that occurs to overcome expiratory resistance by increasing inhalation until the additional elastic recoil pressure is adequate to overcome the resistance. The role of collateral airways is unknown, but it has been postulated that they may play a role in the re-inflation of collapsed airways.
6. PEP breathing has been shown to increase lung capacities and gas exchange while decreasing atelectasis in healthy subjects, surgical patients, cystic fibrosis (CF) patients, pulmonary disease patients, and neuromuscular illness patients.
7. The treatment's physiologic effect is described as a reduction in expiratory flow during PEP, which lessens the pressure drop across the airway wall and thereby reduces airway collapse. Another theory is that higher airway pressure causes EPP to migrate to more central and stable airways, reducing the chance of airway closure [7].
8. When compared to spontaneous breathing, extended expiration breathing provided more efficient ventilation due to lower VE, VE/ VO2, VE/ VCO2, and VE/ VCO2 slope, enhanced oxygen uptake, and greater exercise efficiency due to higher VO2 and delta VO2/delta work rate. The increased VT and decreased fR are thought to reduce dead space ventilation and boost alveolar ventilation, resulting in improved ventilation efficiency.
9. Prolonged expiration Breathing reduces both, the decrease in parasympathetic neural activity after beginning progressive exercise and also the rise in sympathetic nervous activity when the intensity of the exercise exceeds the anaerobic threshold. The central respiratory drive is known to be coordinated with autonomic nerve activity. As a result, during inspiration, parasympathetic nerve activity reduces and increases during expiration. Sympathetic nerve activity, on the other hand, reduces during expiration [8].

5. Conclusions

This study highlights the effect of PEP breathing on VO2max, SPO2 and PR among obese class I in Miraj. P-value is zero, which is less than 5% level of significance. So we may reject H0. In other words, we can accept alternative hypotheses H1. The PEP breathing technique has significant effects on patients. From the mean difference value it is visible that PEP breathing on VO2max, SPO2 and PR (44.03, 98.56 and 146.81) is more effective than habitual breathing on VO2max,

SPO2 and PR (39.90, 97.94 and 159.17) and significance is also seen, thus stating that immediate effect of PEP breathing to be more effective and beneficial in obese class I individuals.

6. Acknowledgment

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